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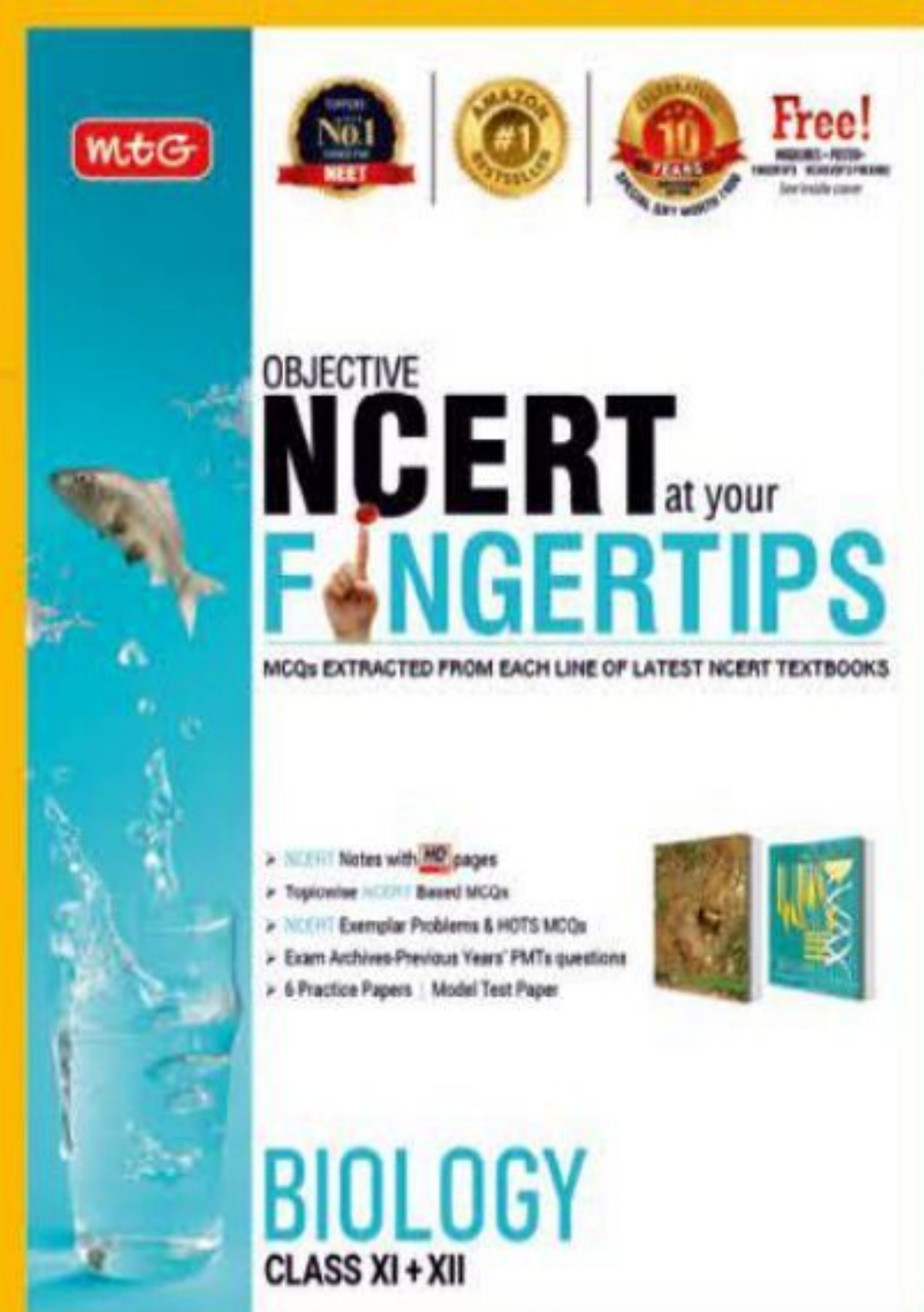
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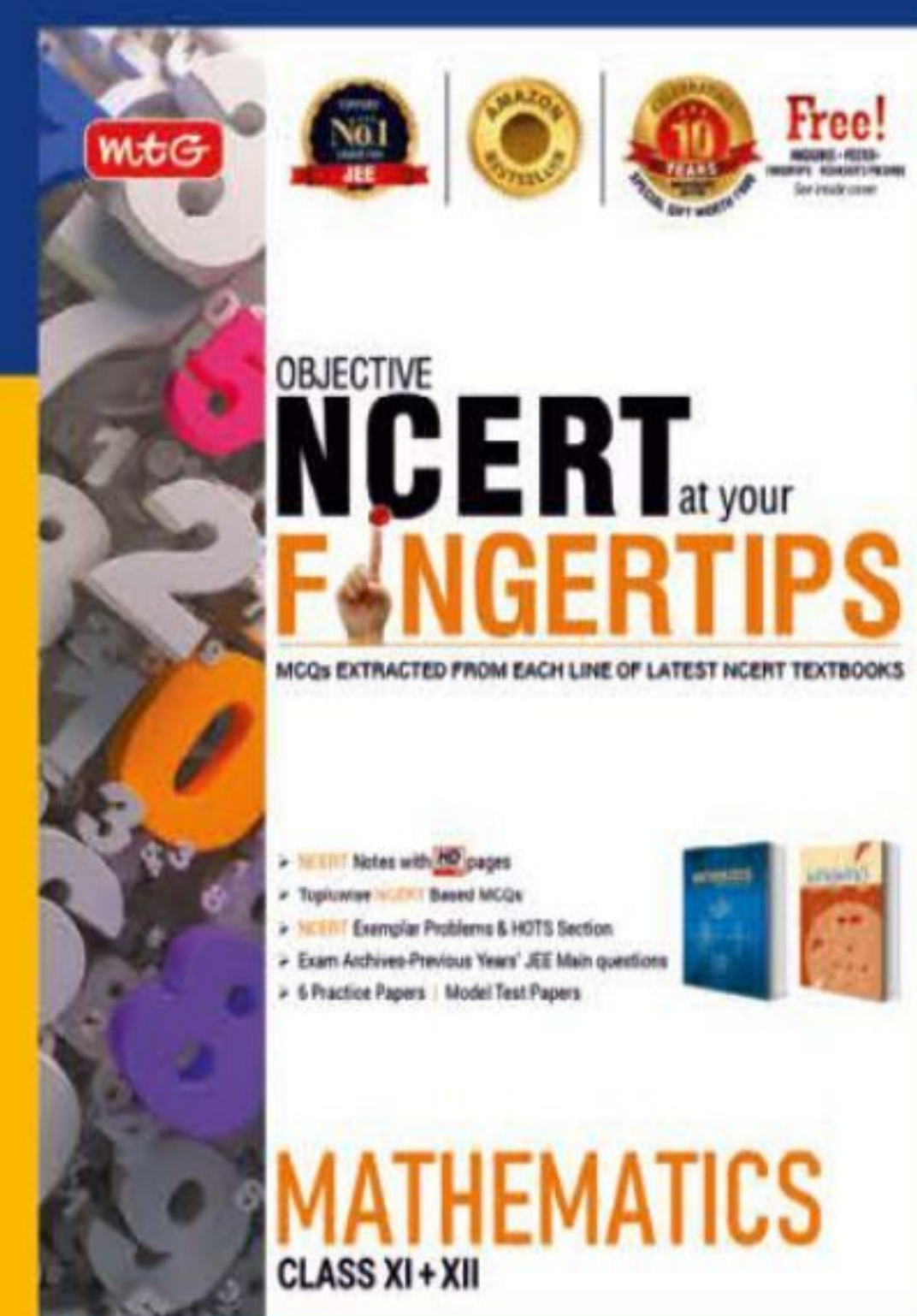
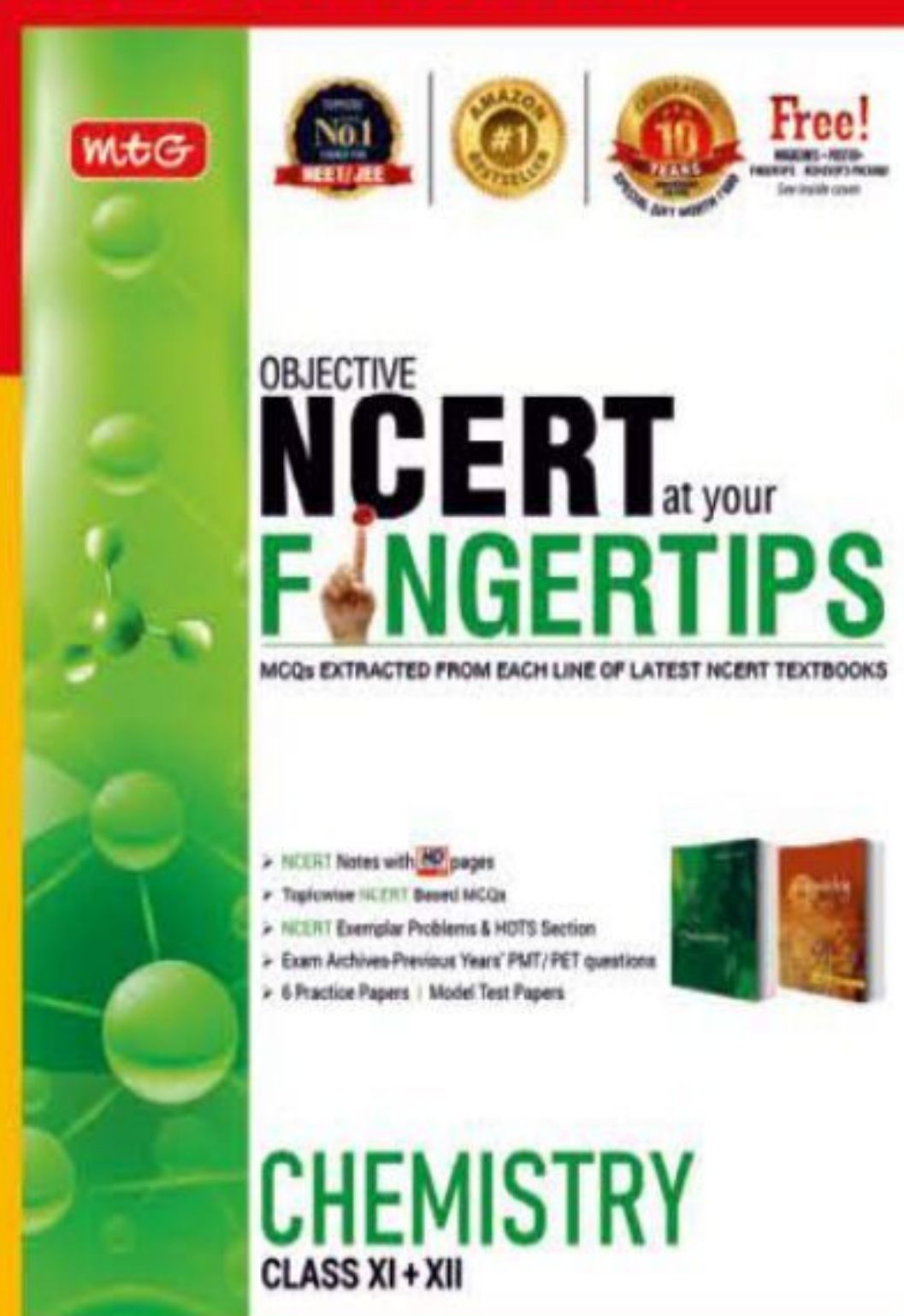
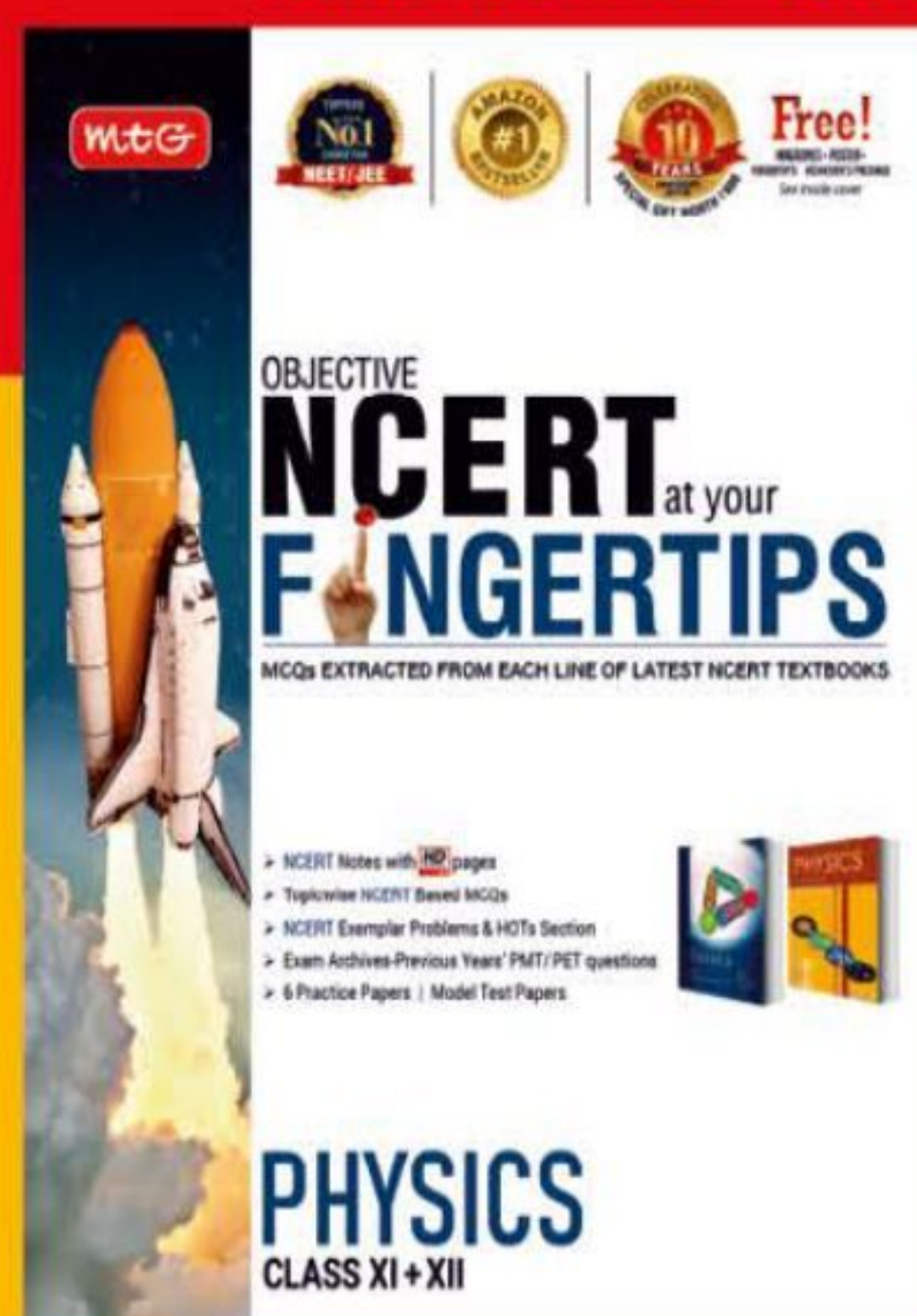
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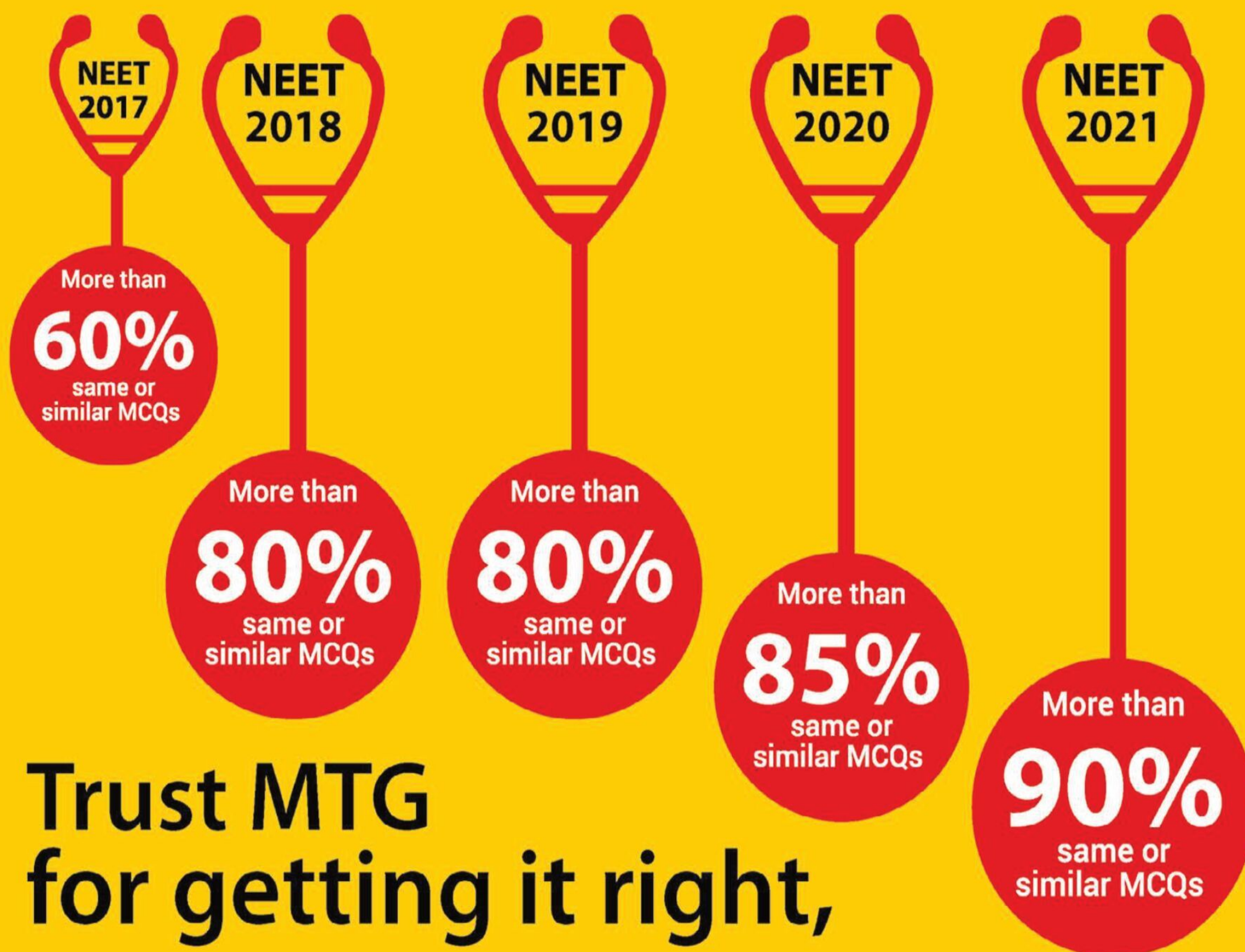


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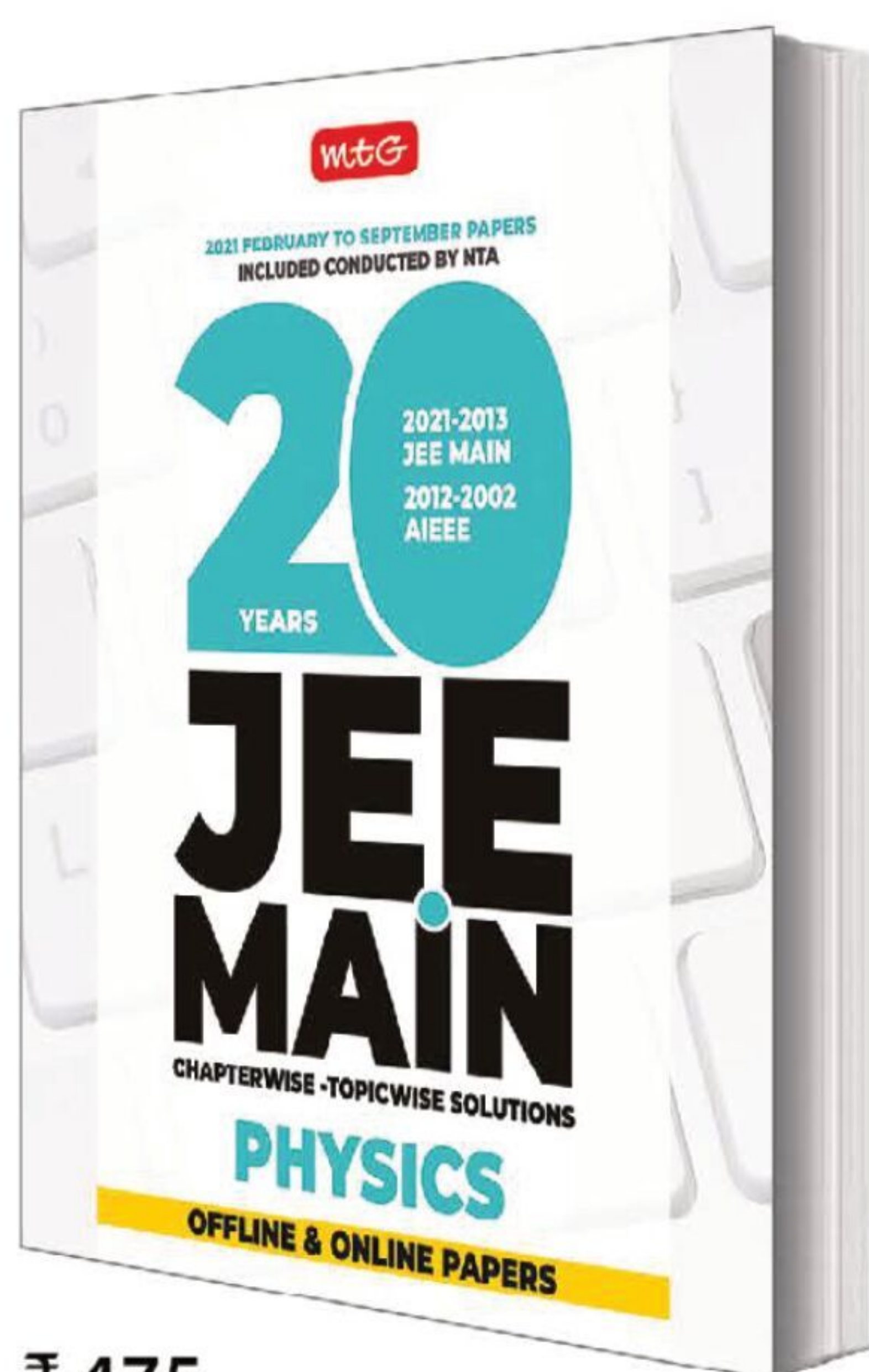


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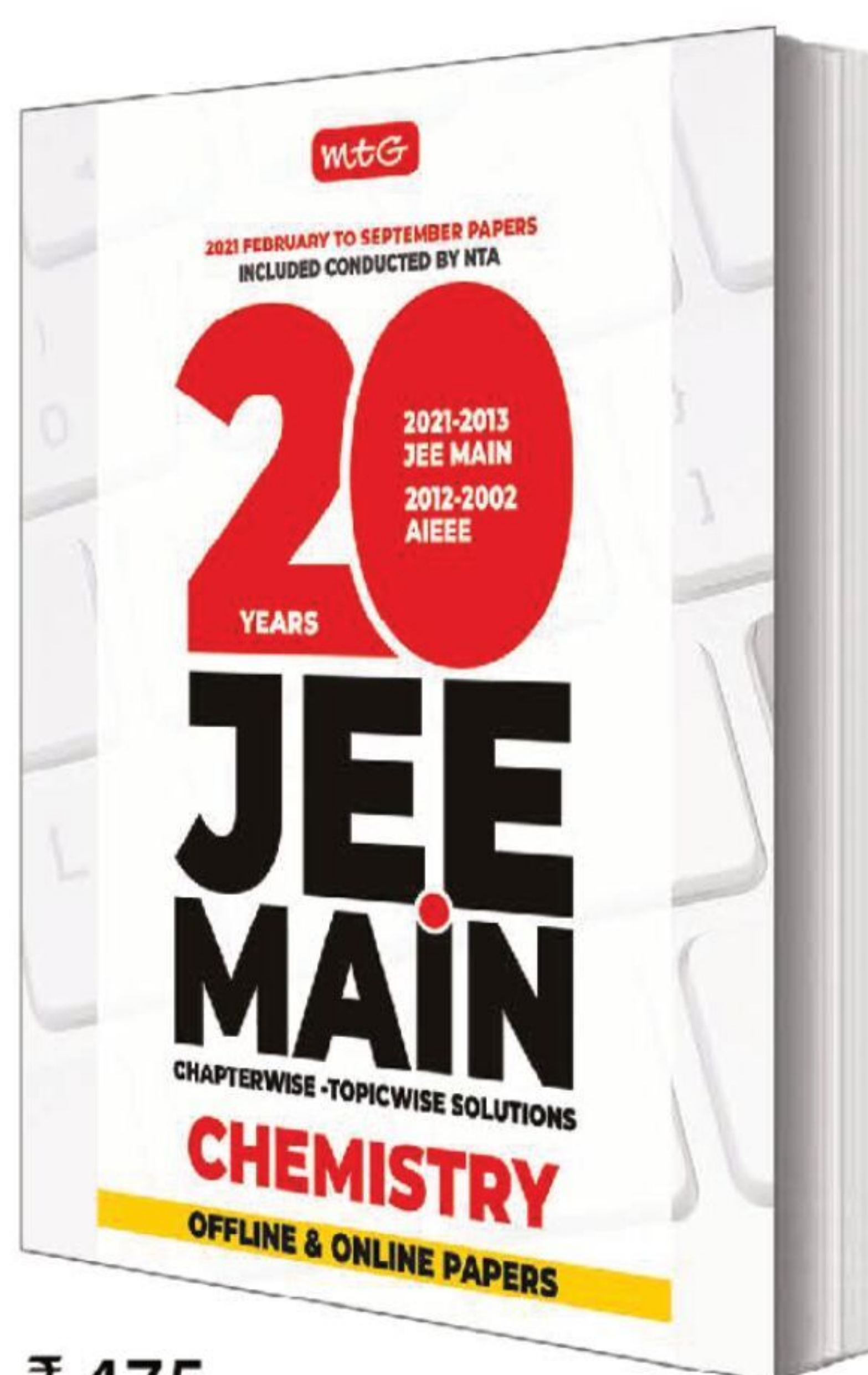


The Best tool for success in JEE Main

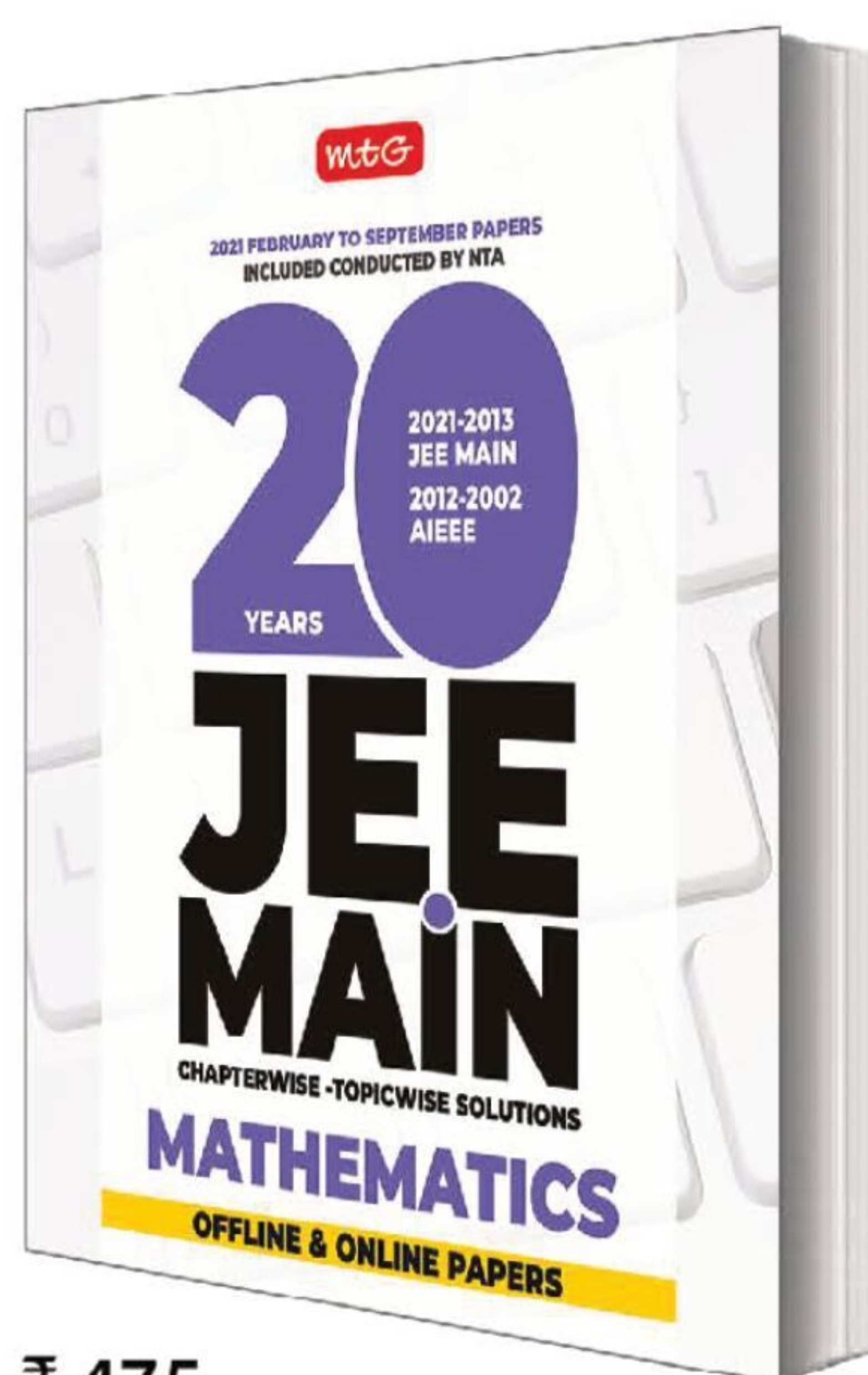
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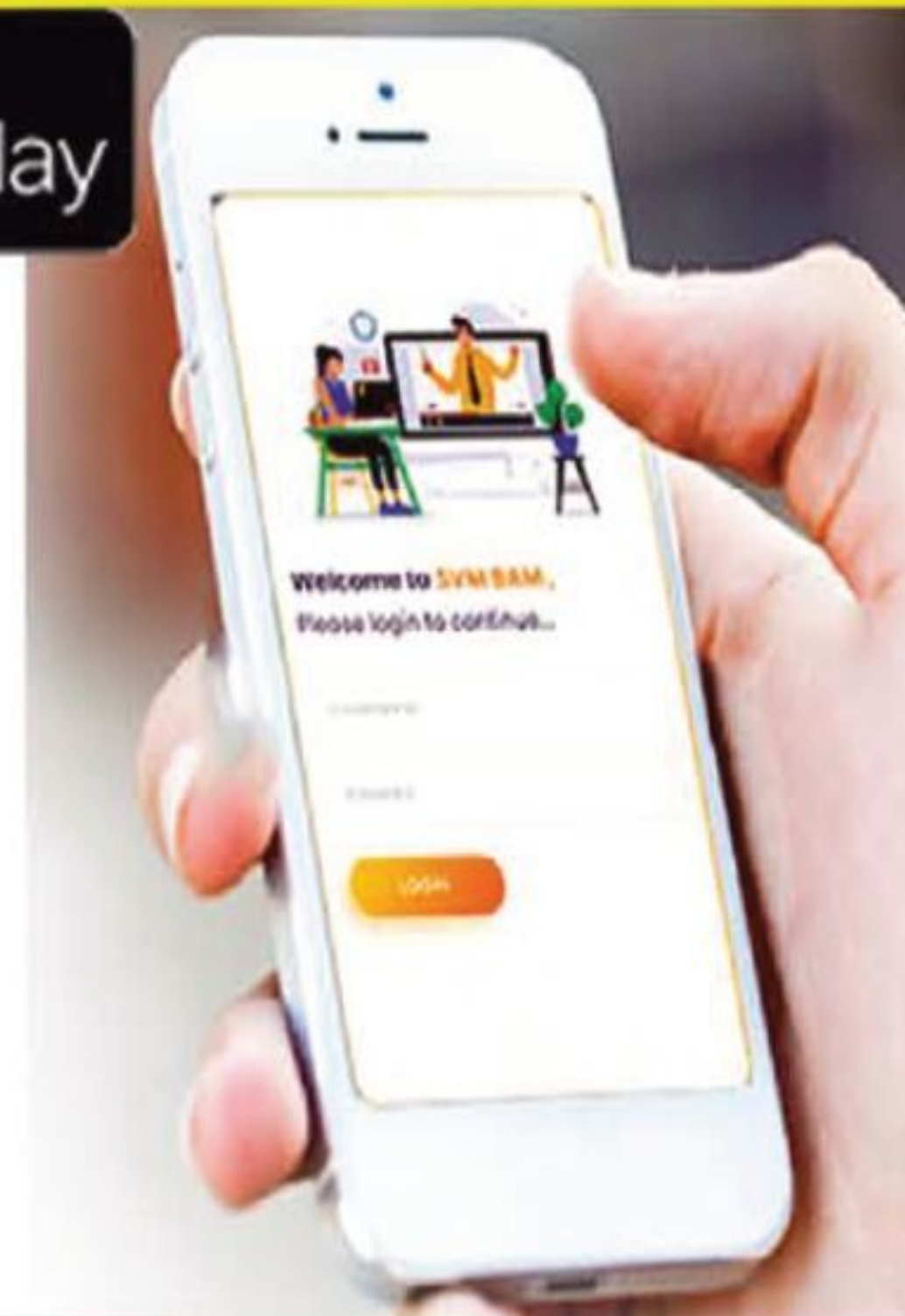
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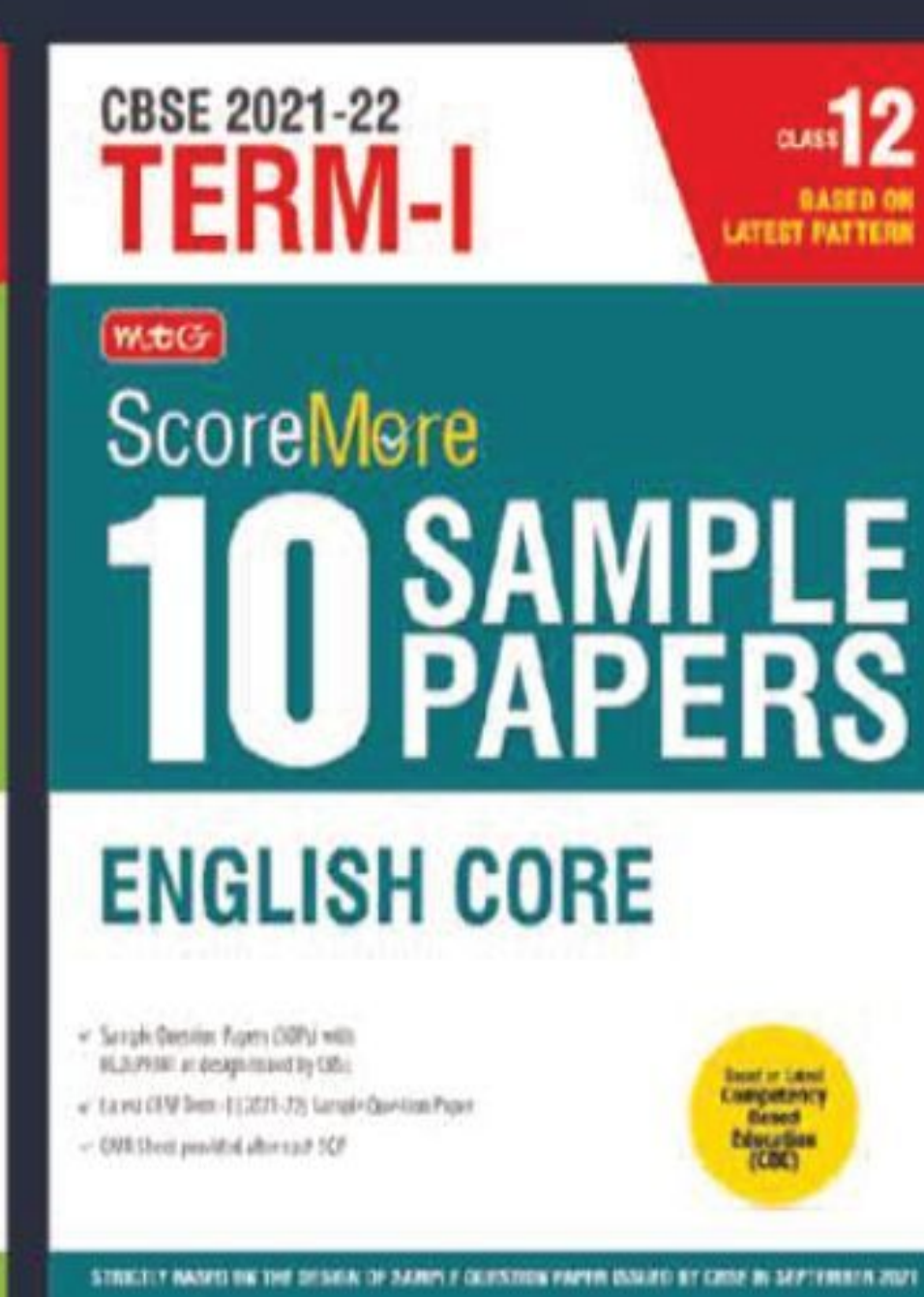
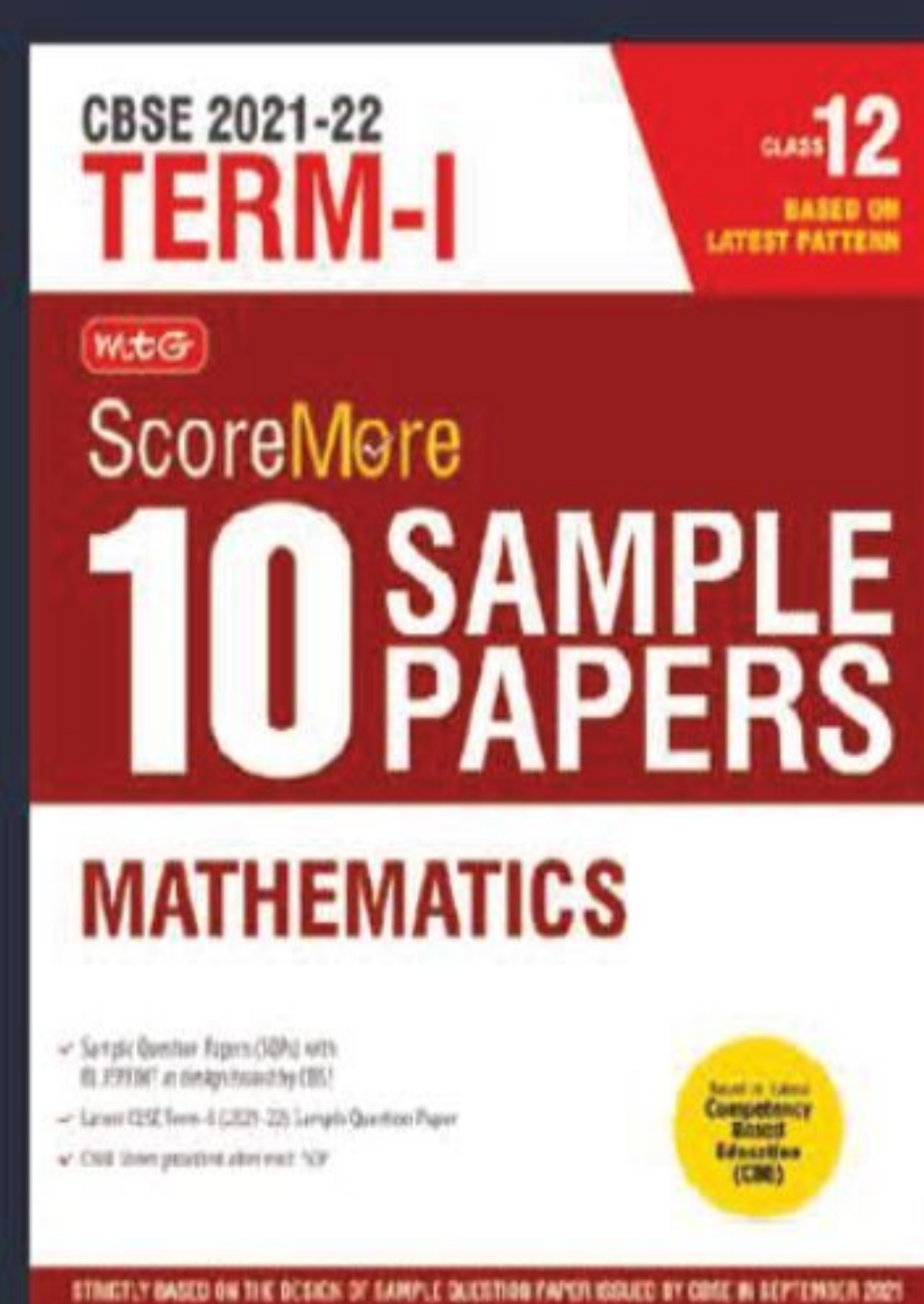
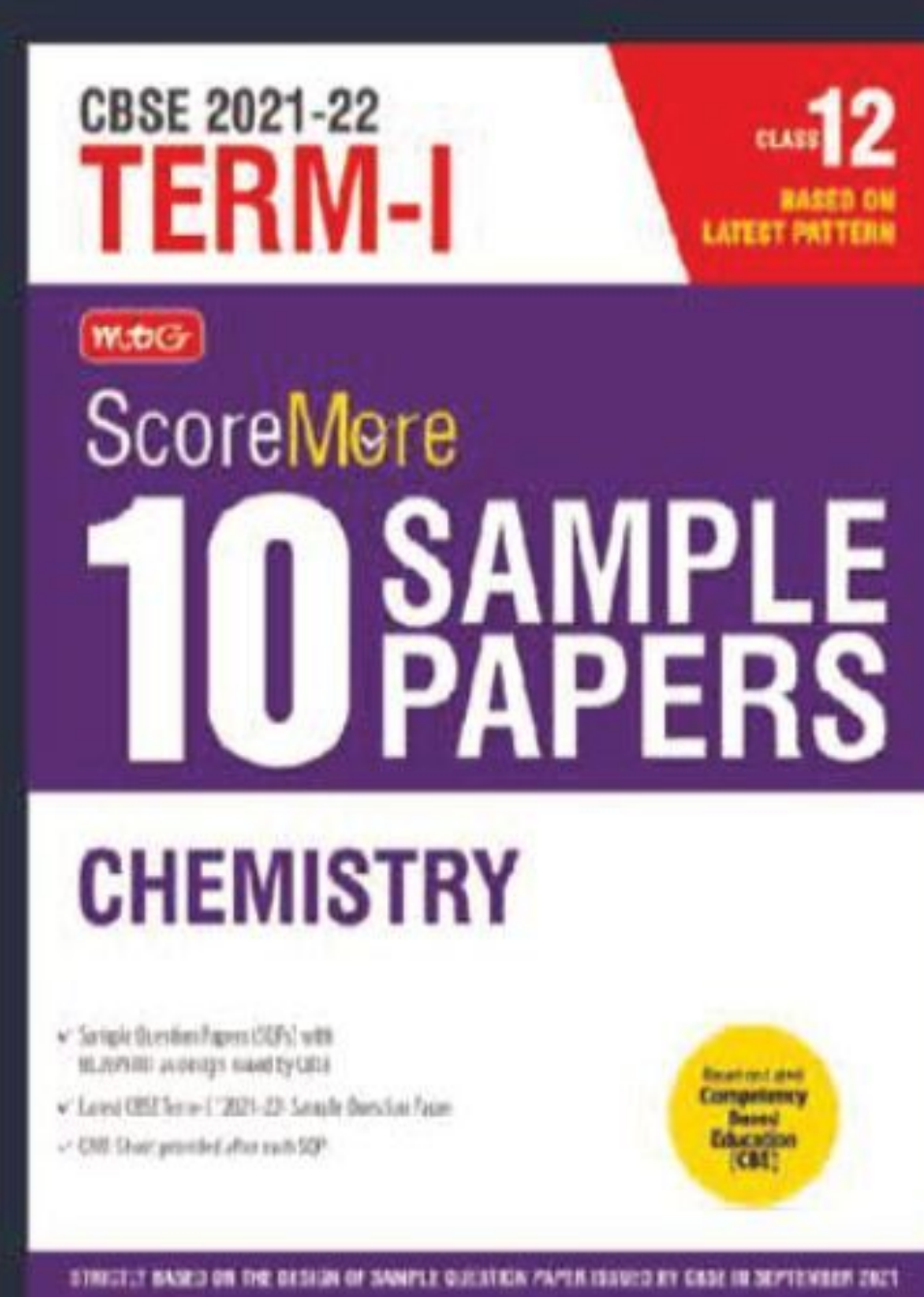
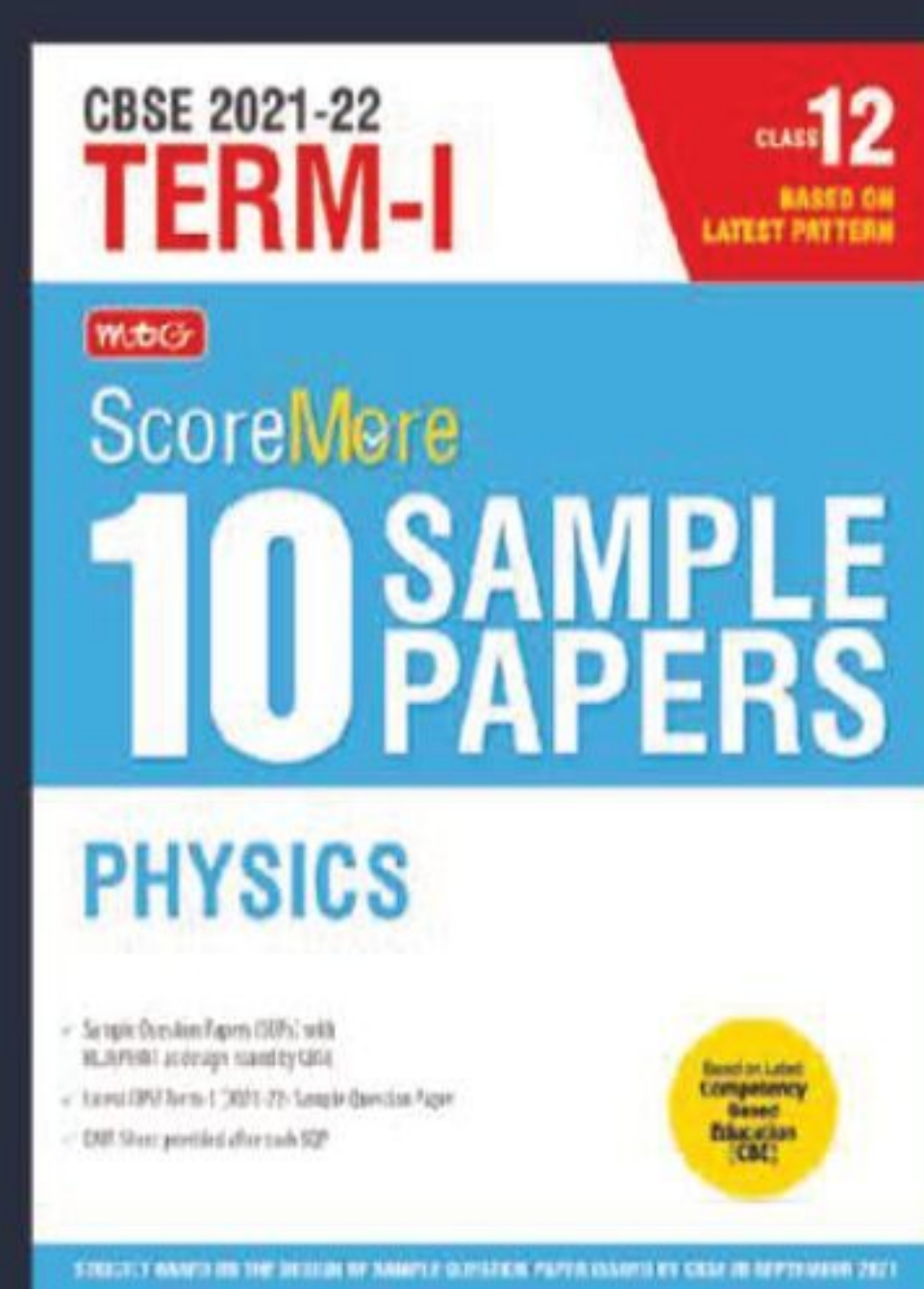
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Thinking of taking a break for JEE and NEET?

Before you decide on taking a year off to study exclusively for JEE or NEET, you need to weigh the pros and cons carefully.

To drop a year or not to, can ring in a Shakespearean dilemma for you. Taking a year's break to prepare for competitive exams such as the Joint Entrance Exam (JEE) and National Eligibility cum Entrance Test (UG) (NEET) can be a monumental decision. One needs to evaluate the pros and cons before taking a call on this. Let us help you. Let's look at the benefits that dropping a year after your Class 12 board exams may bring.

The Pros

Shot at a better college : This may be the sole reason for taking a break for preparation, so a break can provide you the time to work hard and aim for your dream college in the next attempt.

Complete focus : This break also means you have no school or practicals to worry about. With boards out of the way, you can dedicate yourself fully to JEE or NEET preparations.

Condensed syllabus : You do not have to divert your attention to topics that may not be important for JEE or NEET. You can concentrate exclusively on the exam syllabus.

Clearing Concepts : Being clear about concepts is an important factor to do well in exams such as JEE and NEET. If you need to clear your concepts after your Class 11 and 12, dropping a year might help you.

More practice : You can devote more time to practice and go through all previous years' question papers, mock tests and chapter-wise tests that you missed before.

Working on areas to improve and time management: Taking the JEE or NEET once would have given you a good understanding about what are your strong subjects and topics. It would have also highlighted the areas you would want to improve. You can take the year to address these. You can also further improve on your time management and plan your study schedule thoroughly.

The Cons

With the extra time comes extra stress. It's possibly the first big decision you make as a young adult. Hence, you must understand what it really means and what you can expect in the coming year.

Absence of a routine : While the absence of regular school gives you more time to prepare, it also means a deviation from a daily routine. It's easy to become unproductive without supervision. If you are dropping a year, make sure

to carve your own schedule and adhere to it religiously. It becomes easier if you join a coaching program and have scheduled classes. If you are struggling to follow the routine you have created, enlist parents or friends to help you stick to your schedule.

Repetitive syllabus : Picking up the same books and studying the topics you have been studying in the previous years may become tiresome. Don't forget that understanding and grasping the topics well are the reasons you are taking this break. Stay focused. Don't let lethargy set in.

Bearing boredom : With no external routines such as school or extracurriculars to follow, you may also be prone to boredom. Online games or social media can be addictive and may end up being a distraction. Cultivate healthy outlets such as outdoor sports, reading or music.

Performance pressure : Don't get bogged down by curious relatives, pressing parents or peers. Take it in your stride. Don't worry about things you cannot control. Remember: If the end result is not success, then at least you will have the satisfaction of knowing it wasn't because you didn't try.

The burden of peers : Several of your friends and schoolmates may be joining colleges and moving on to other things. Learning about their new colleges and exciting days may waver your determination and induce fear of missing out. This may cause unnecessary stress. Keep your focus on yourself. Don't lose sight of the goal.

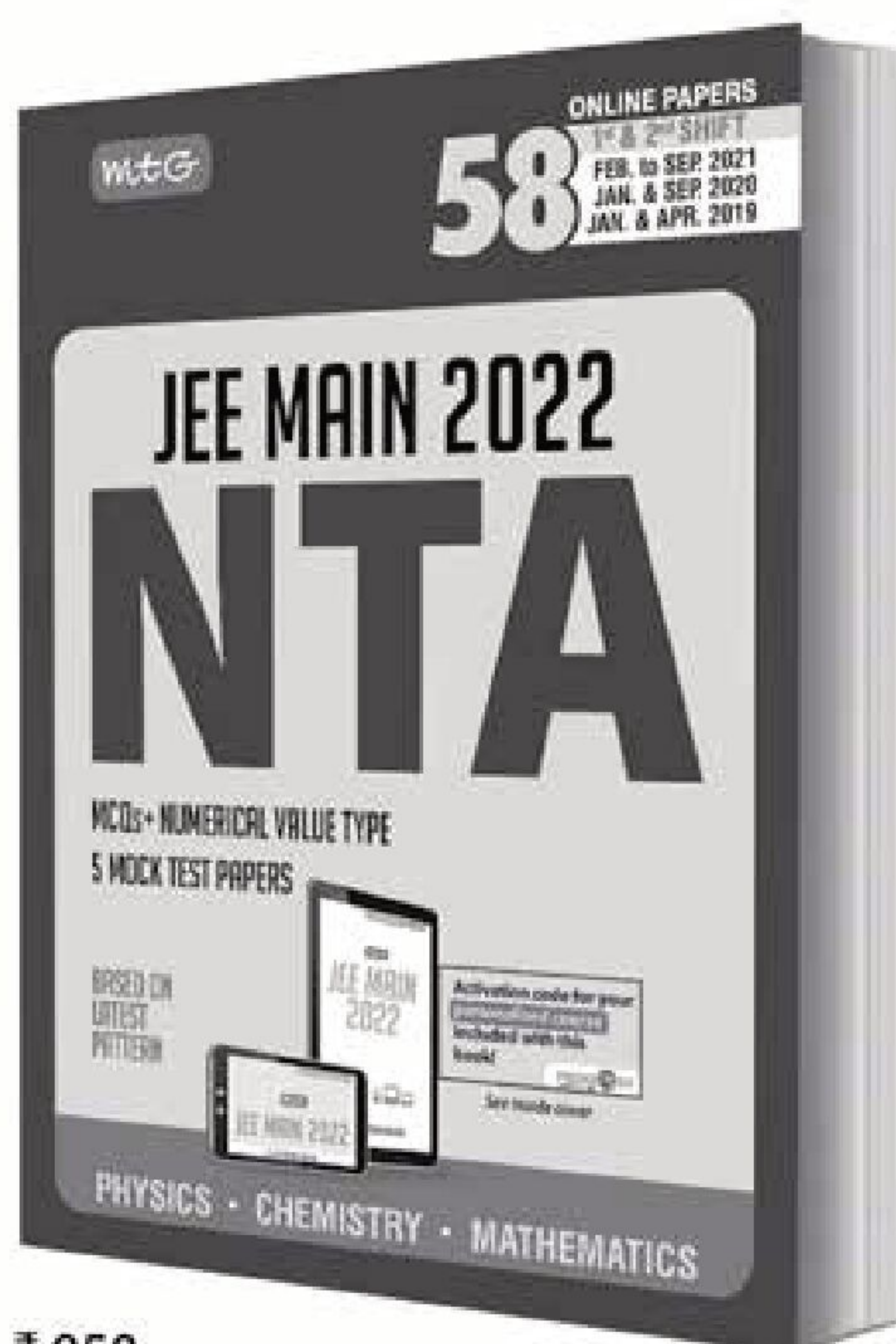
Mental health : All the above factors may contribute to your mental stress. Falling a year behind your peers, missing out on life in college with your peers, the vast syllabus, incessant studying and the endless questions may lead you to doubt your own decision. It's natural. But you need to be strong mentally.

Know this : The long year ahead will throw up more challenges but you must tower over self-doubts to conquer what you set out to do. We hope these pros and cons help you in making a decision that's best for you. Keep your eye on the goal, everything else is a momentary distraction.

Disclaimer : The information provided in this article is of a general nature and should not be considered a substitute for professional advice.



Reach the peak of readiness for JEE Main 2021



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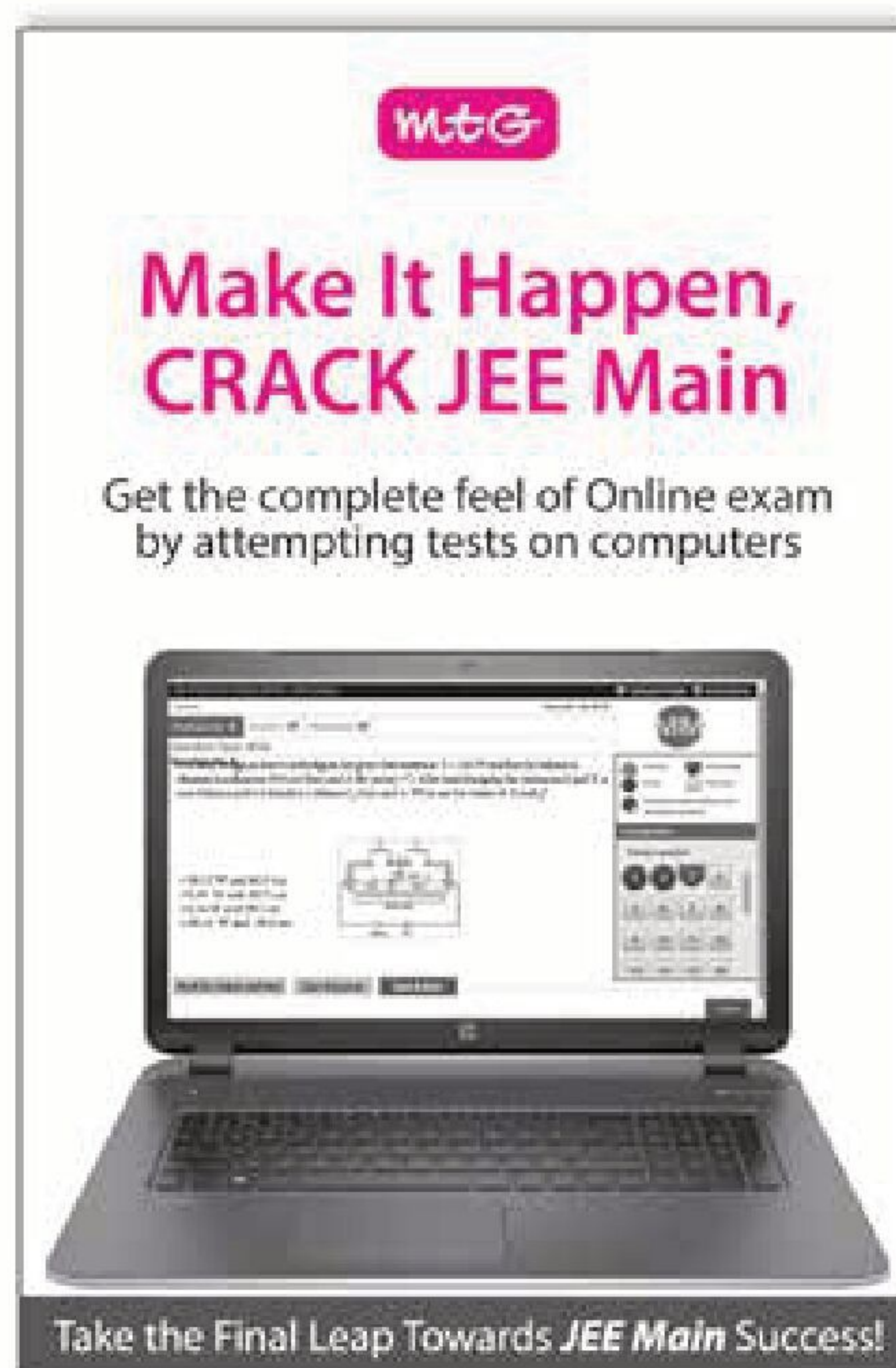
Highlights

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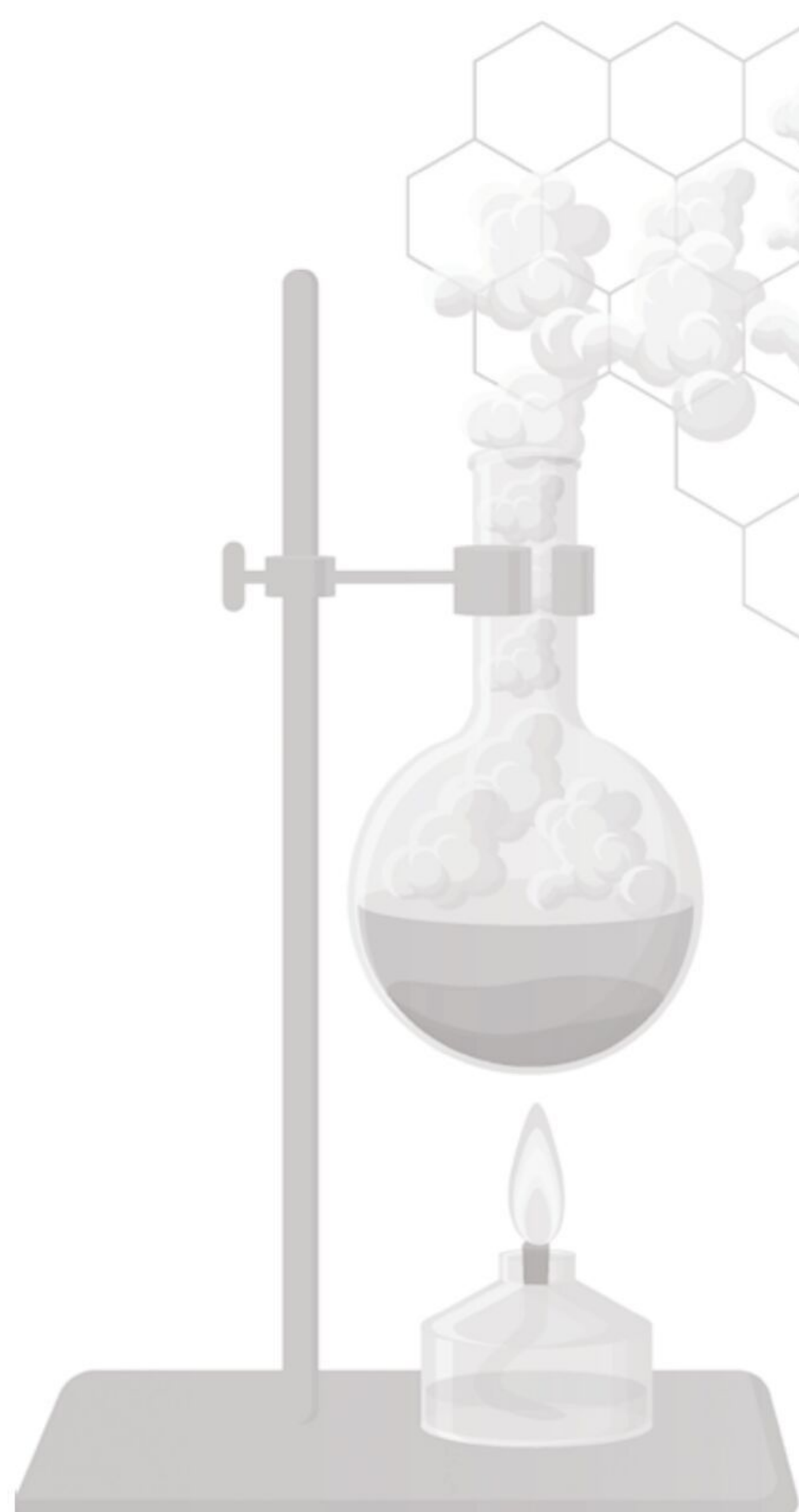
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JEE 2021

Held on
3rd October

SOLVED PAPER

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PAPER - I

SECTION 1

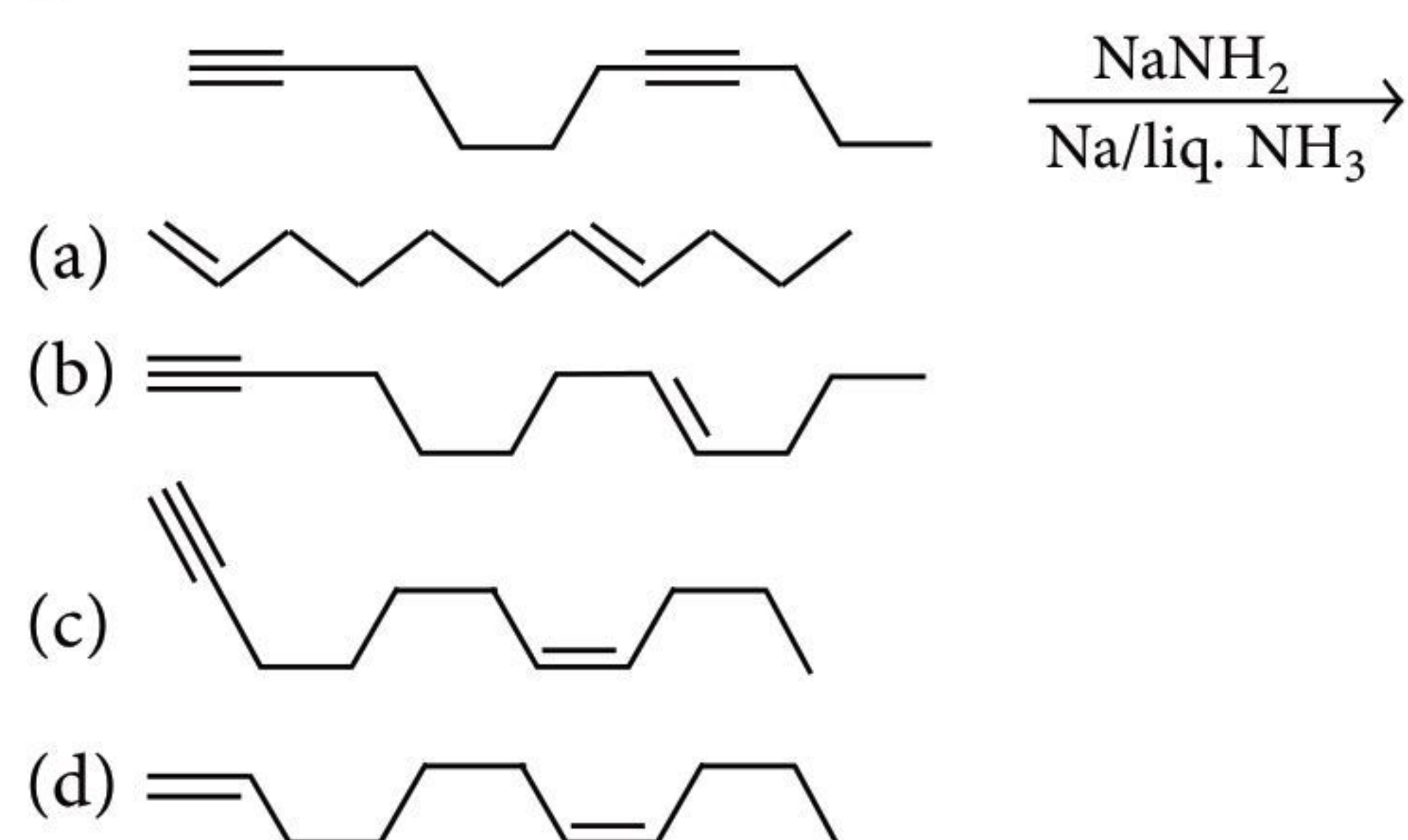
- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (a), (b), (c) and (d). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the correct option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If **ONLY** the correct option is chosen.

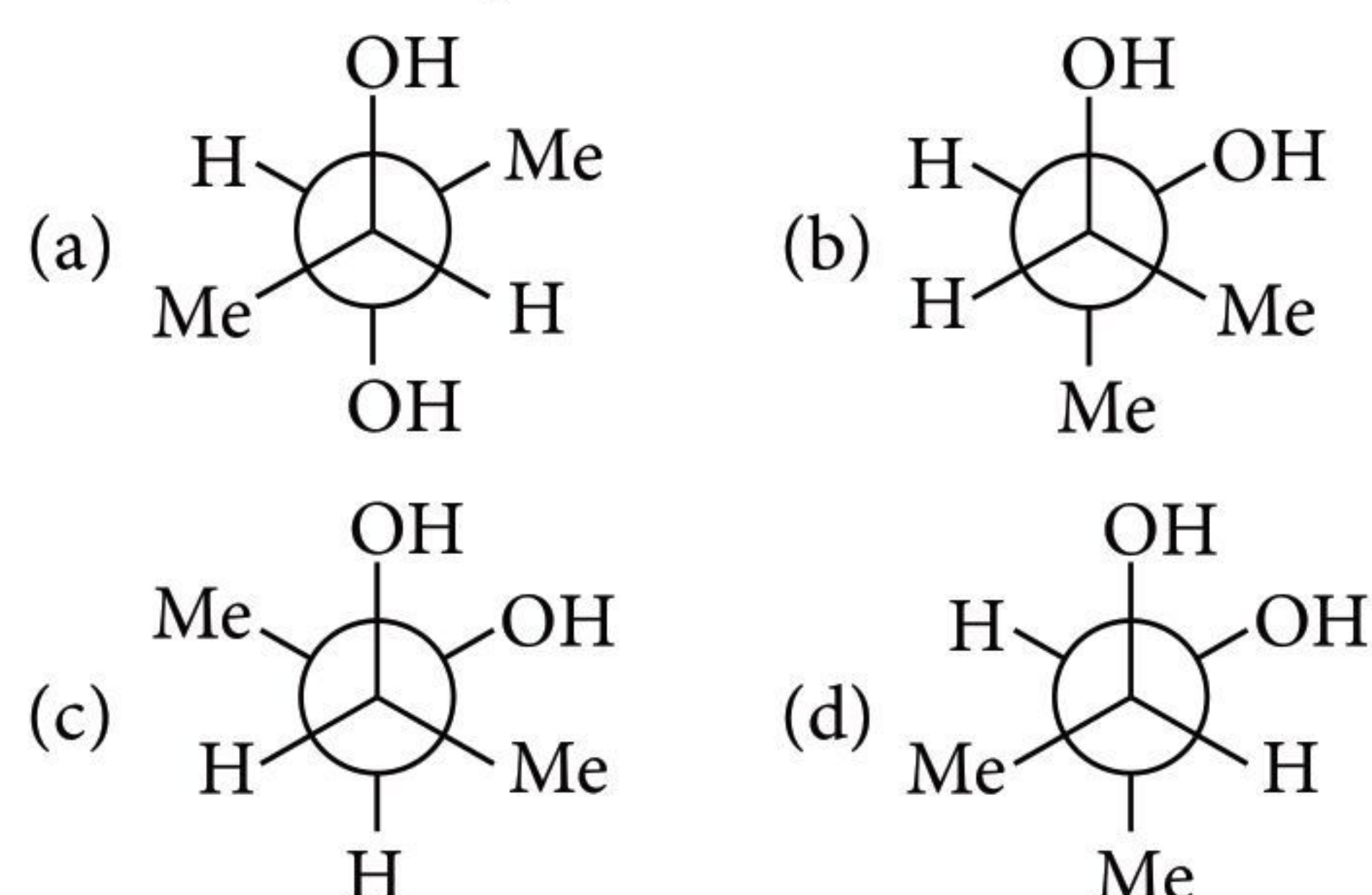
Zero Marks : 0 If none of the options is chosen (i.e., the question is unanswered).

Negative Marks : -1 In all other cases.

1. The major product formed in the following reaction is

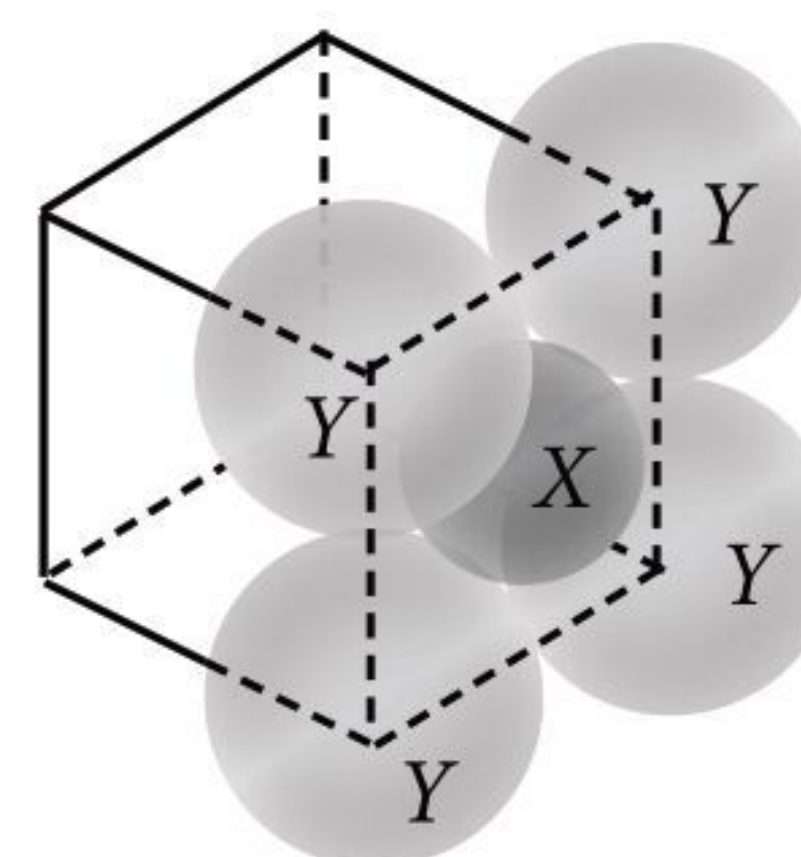


2. Among the following, the conformation that corresponds to the most stable conformation of *meso*-butane-2,3-diol is



3. For the given close packed structure of a salt made of cation X and anion Y shown below (ions of only one face are shown for clarity), the packing fraction is approximately

$$\left(\text{Packing fraction} = \frac{\text{packing efficiency}}{100} \right)$$



- (a) 0.74 (b) 0.63 (c) 0.52 (d) 0.48
4. The calculated spin only magnetic moments of $[\text{Cr}(\text{NH}_3)_6]^{3+}$ and $[\text{CuF}_6]^{3-}$ in BM, respectively, are (Atomic numbers of Cr and Cu are 24 and 29, respectively.)
- (a) 3.87 and 2.84 (b) 4.90 and 1.73
(c) 3.87 and 1.73 (d) 4.90 and 2.84

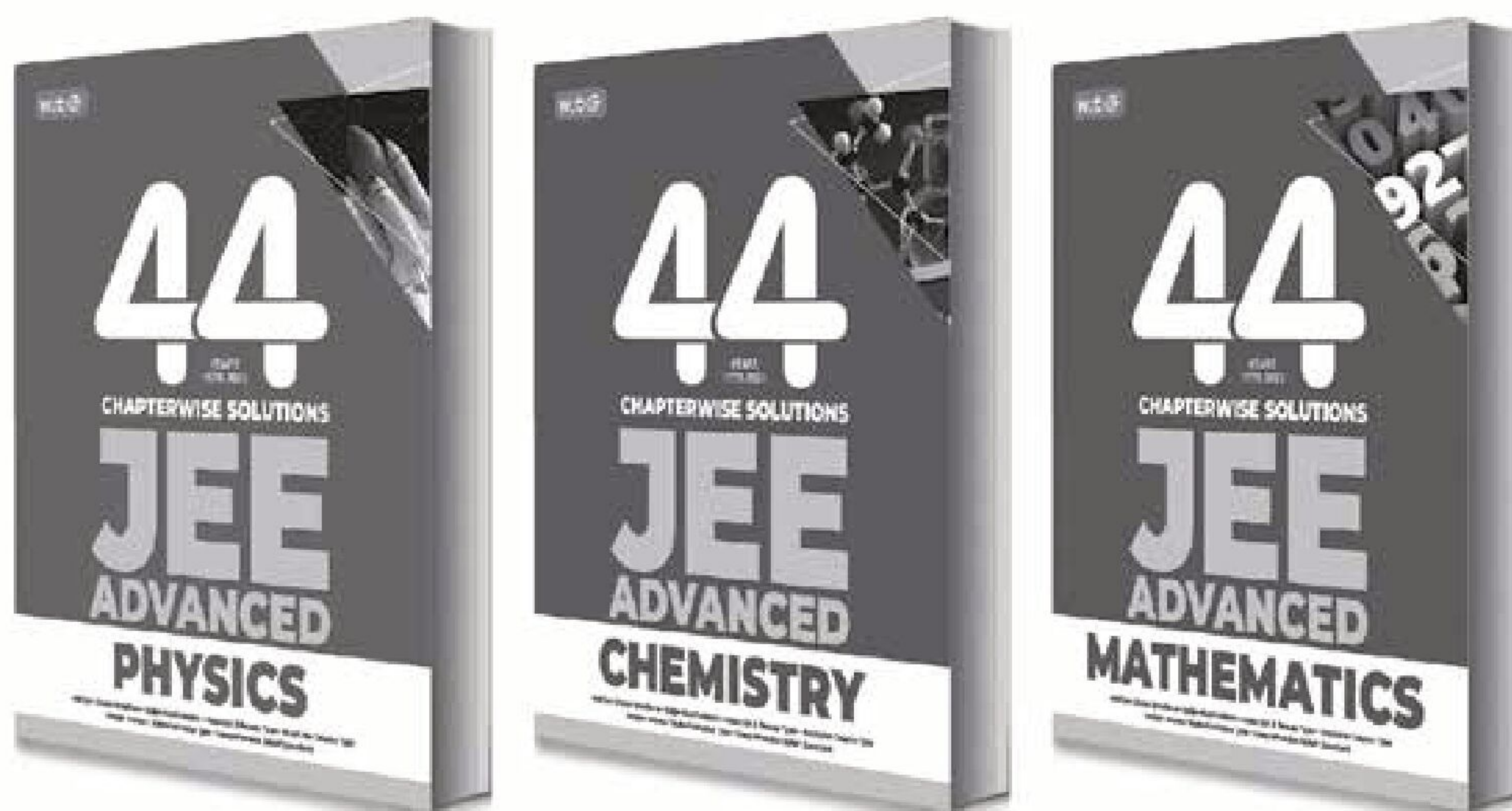
SECTION 2

- This section contains **THREE (03)** question stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +2 If **ONLY** the correct numerical value is entered at the designated place

Zero Marks : 0 In all other cases.

How can history help to succeed in JEE!



Wouldn't you agree that previous years' test papers provide great insights into the pattern and structure of future tests. Studies corroborate this, and have shown that successful JEE aspirants begin by familiarising themselves with problems that have appeared in past JEEs, as early as 2 years in advance.

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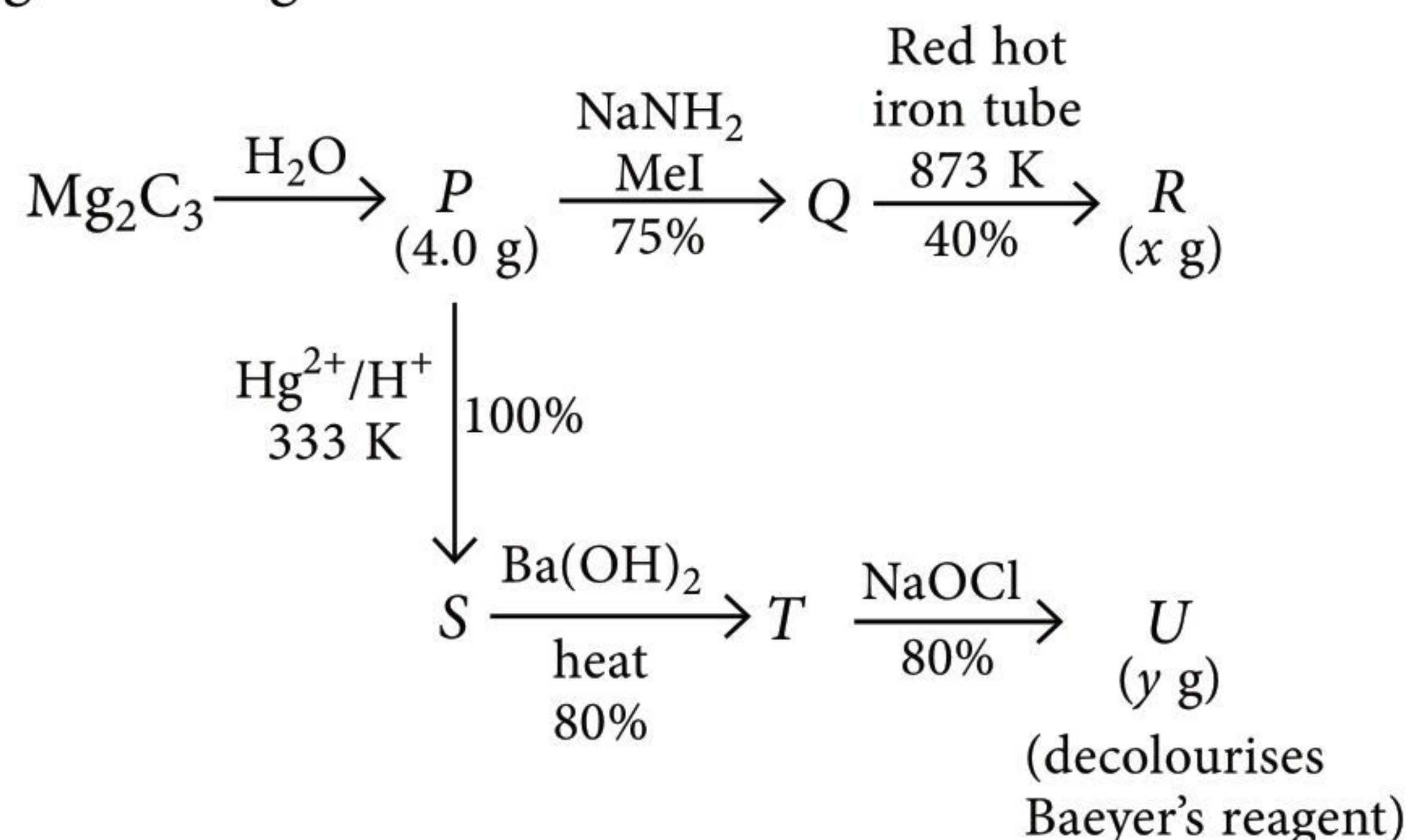
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Question Stem for Question Nos. 5 and 6

Question Stem

For the following reaction scheme, percentage yields are given along the arrow :



x g and y g are mass of R and U , respectively.

(Use: Molar mass (in g mol^{-1}) of H, C and O as 1, 12 and 16, respectively)

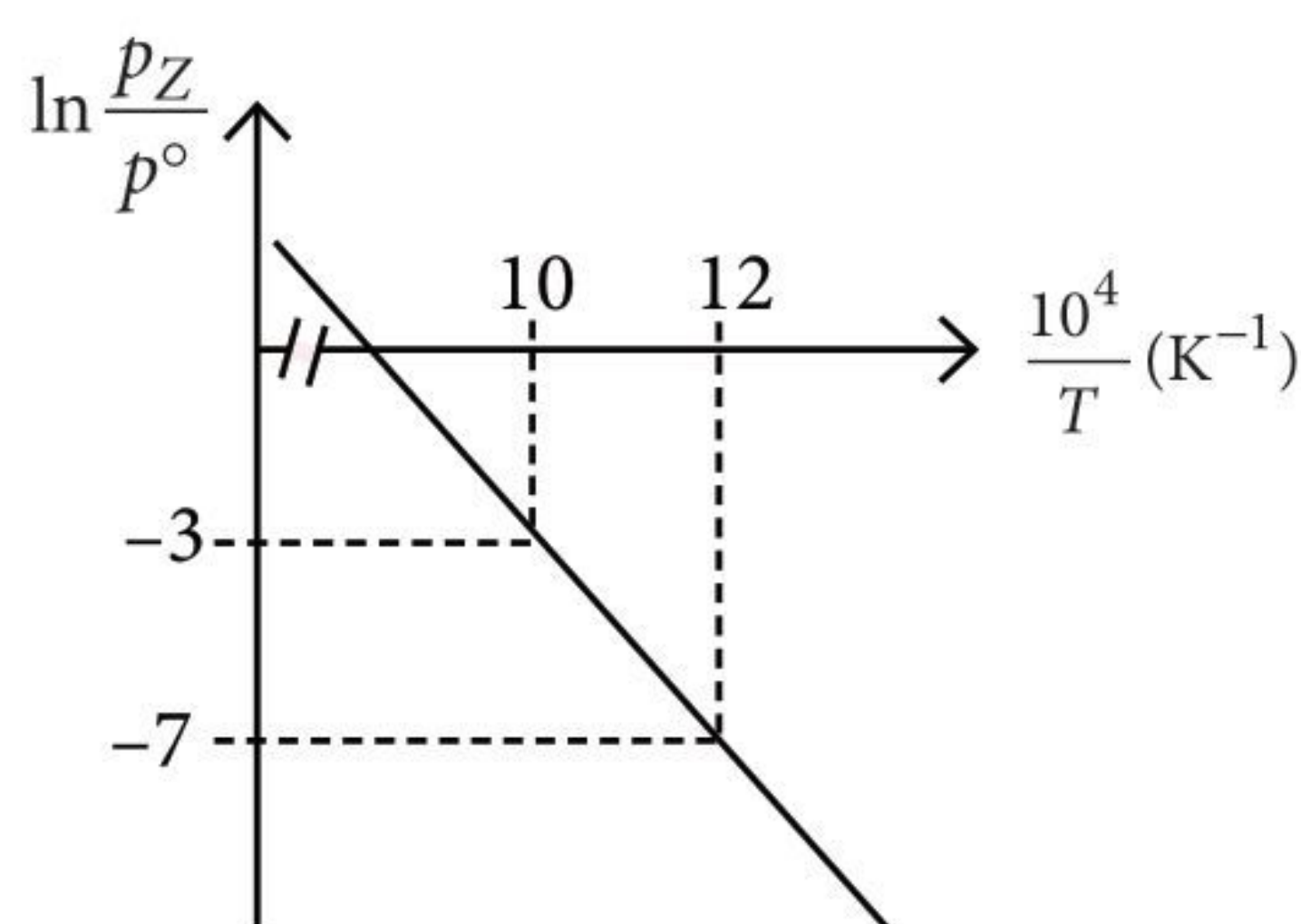
5. The value of x is _____.

6. The value of y is _____.

Question Stem for Question Nos. 7 and 8

Question Stem

For the reaction, $X_{(s)} \rightleftharpoons Y_{(s)} + Z_{(g)}$, the plot of $\ln \frac{p_Z}{p^\circ}$ versus $\frac{10^4}{T}$ is given below (in solid line), where p_Z is the pressure (in bar) of the gas Z at temperature T and $p^\circ = 1$ bar.



(Given: $\frac{d(\ln K)}{d(1/T)} = -\frac{\Delta H^\circ}{R}$, where the equilibrium constant,

$K = \frac{p_Z}{p^\circ}$ and the gas constant,

$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)

7. The value of standard enthalpy, ΔH° (in kJ mol^{-1}) for the given reaction is _____.

8. The value of ΔS° (in $\text{J K}^{-1} \text{ mol}^{-1}$) for the given reaction, at 1000 K is _____.

Question Stem for Question Nos. 9 and 10

Question Stem

The boiling point of water in a 0.1 molal silver nitrate solution (solution A) is $x^\circ\text{C}$. To this solution A, an equal volume of 0.1 molal aqueous barium chloride solution is added to make a new solution B. The difference in the boiling points of water in the two solutions A and B is $y \times 10^{-2}^\circ\text{C}$.

(Assume: Densities of the solutions A and B are the same as that of water and the soluble salts dissociate completely.

Use: Molal elevation constant (Ebullioscopic Constant), $K_b = 0.5 \text{ K kg mol}^{-1}$; Boiling point of pure water as 100°C .)

9. The value of x is _____.

10. The value of $|y|$ is _____.

SECTION 3

- This section contains SIX (06) questions.
- Each question has FOUR options (a), (b), (c) and (d). ONE OR MORE THAN ONE of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is(are) chosen;

Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;

Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;

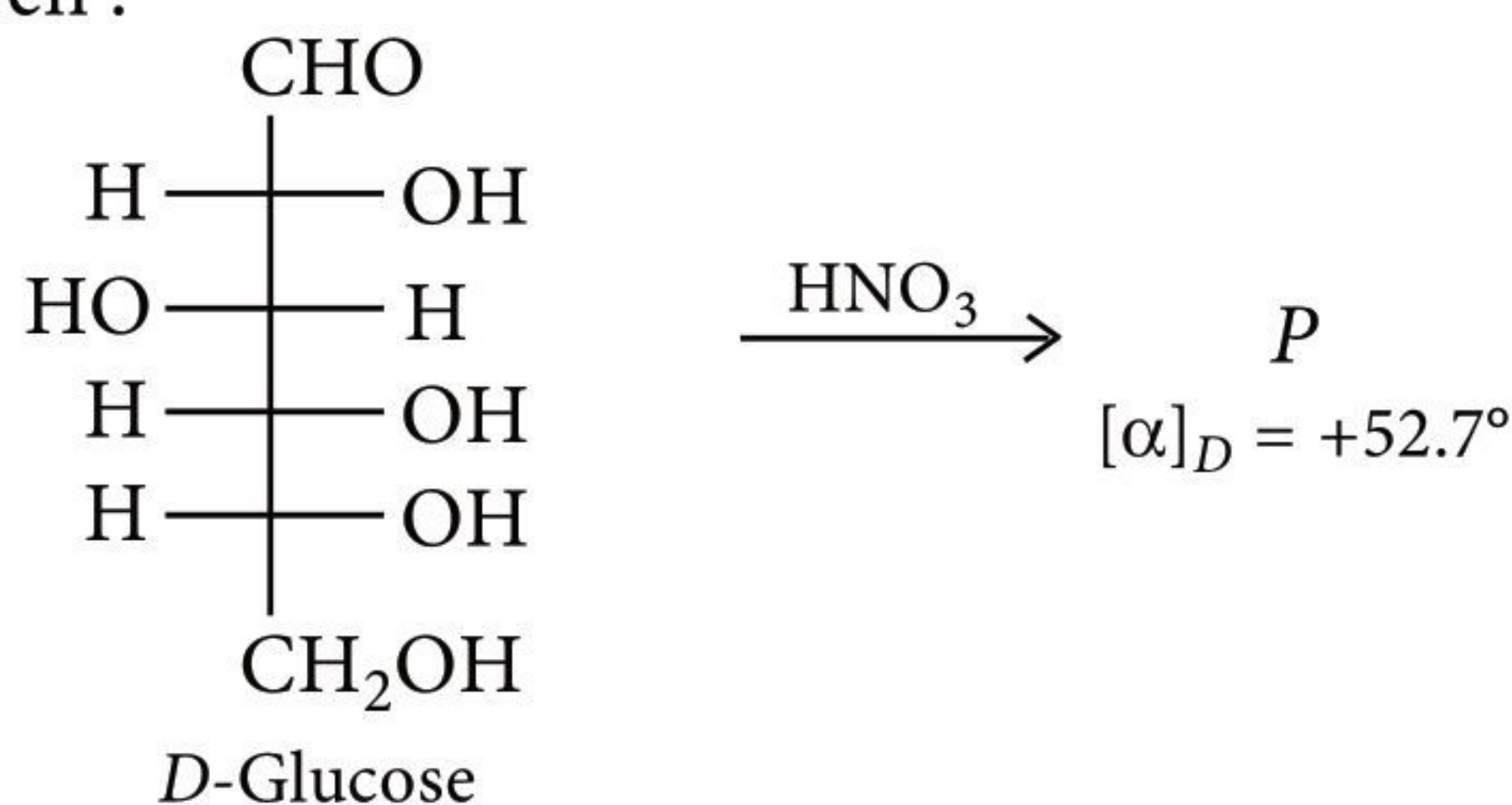
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;

Zero Marks : 0 If unanswered;

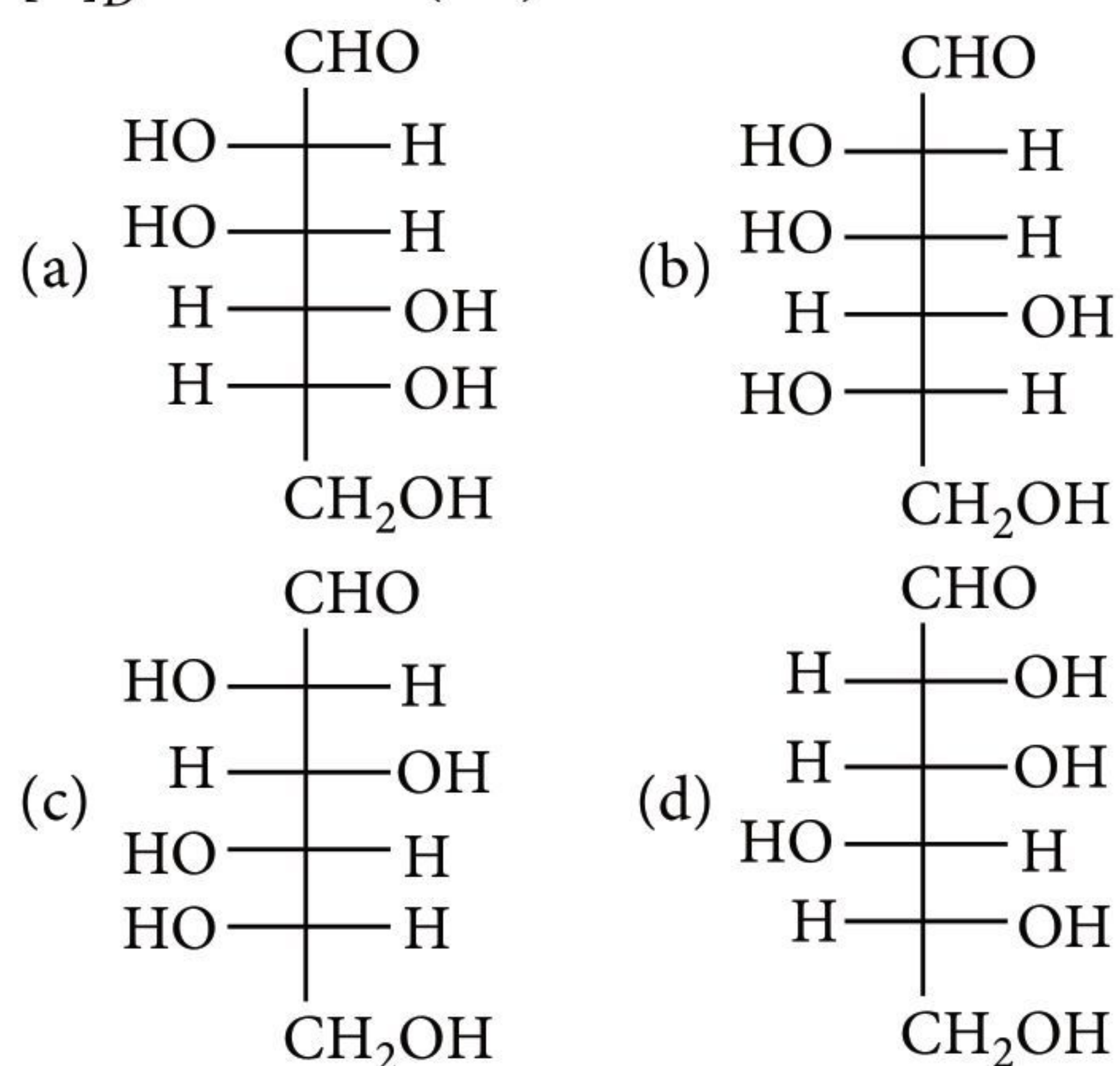
Negative Marks : -2 In all other cases.

For example, in a question, if (a), (b) and (d) are the ONLY three options corresponding to correct answers, then choosing ONLY (a), (b) and (d) will get +4 marks; choosing ONLY (a) and (b) will get +2 marks; choosing ONLY (a) and (d) will get +2 marks; choosing ONLY (b) and (d) will get +2 marks; choosing ONLY (a) will get +1 mark; choosing ONLY (b) will get +1 mark; choosing ONLY (d) will get +1 mark; choosing no option(s) (i.e., the question is unanswered) will get 0 marks and choosing any other option(s) will get -2 marks.

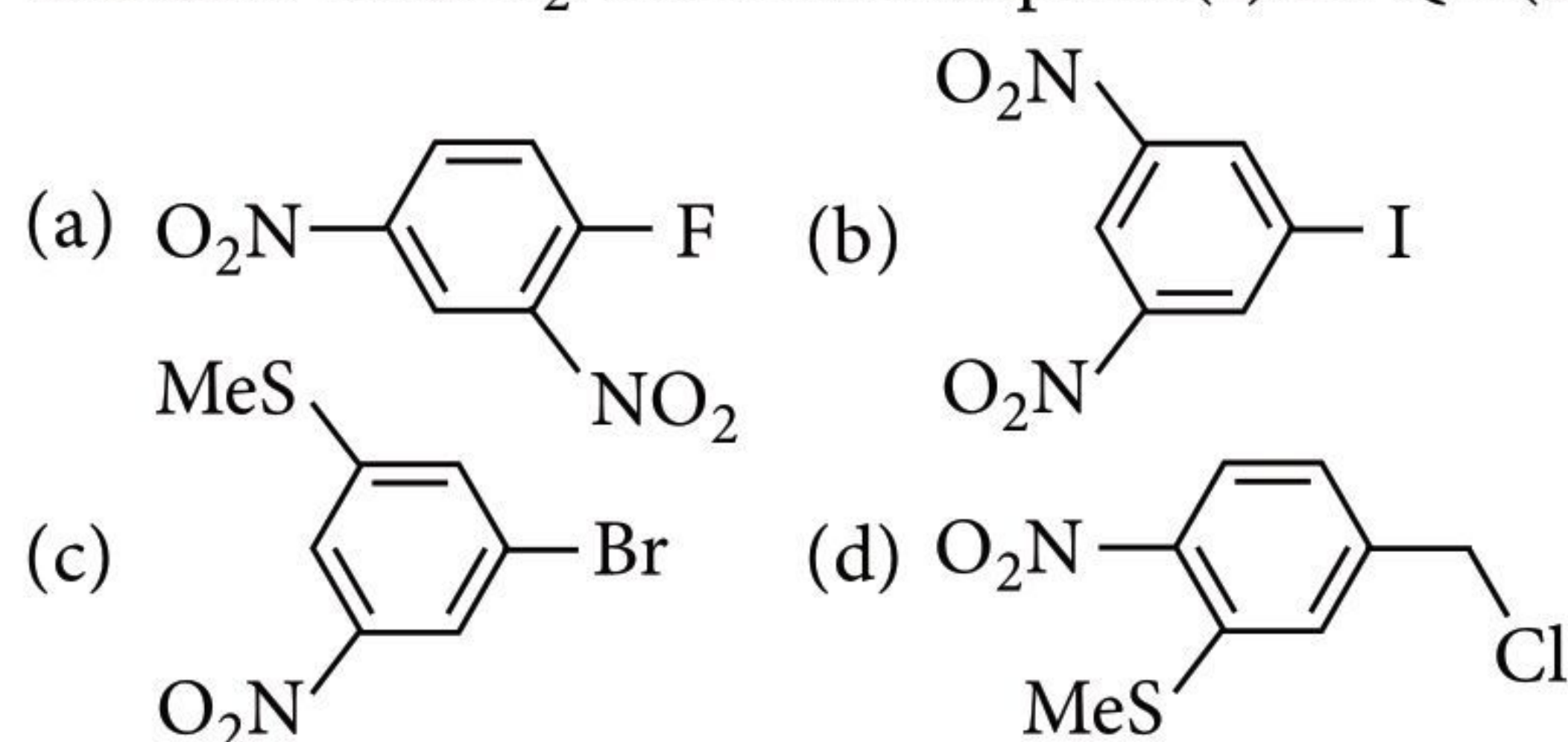
11. Given :



The compound(s), which on reaction with HNO_3 will give the product having degree of rotation, $[\alpha]_D = -52.7^\circ$ is(are)



12. The reaction of Q with PhSNa yields an organic compound (major product) that gives positive Carius test on treatment with Na_2O_2 followed by addition of BaCl_2 . The correct option(s) for Q is(are)



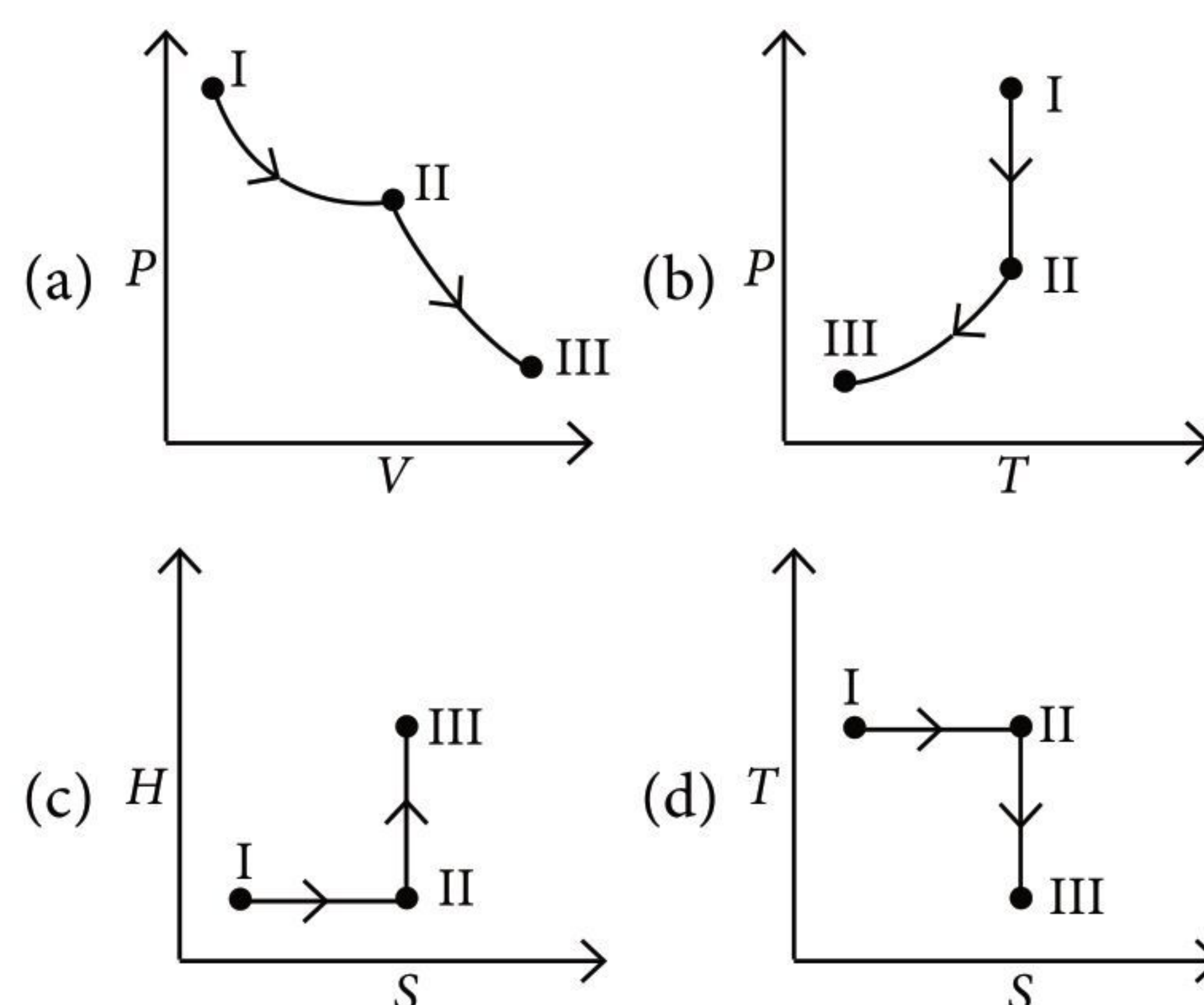
13. The correct statement(s) related to colloids is(are)

- the process of precipitating colloidal sol by an electrolyte is called peptization
- colloidal solution freezes at higher temperature than the true solution at the same concentration
- surfactants form micelle above critical micelle concentration (CMC). CMC depends on temperature
- micelles are macromolecular colloids.

14. An ideal gas undergoes a reversible isothermal expansion from state I to state II followed by a

reversible adiabatic expansion from state II to state III. The correct plot(s) representing the changes from state I to state III is(are)

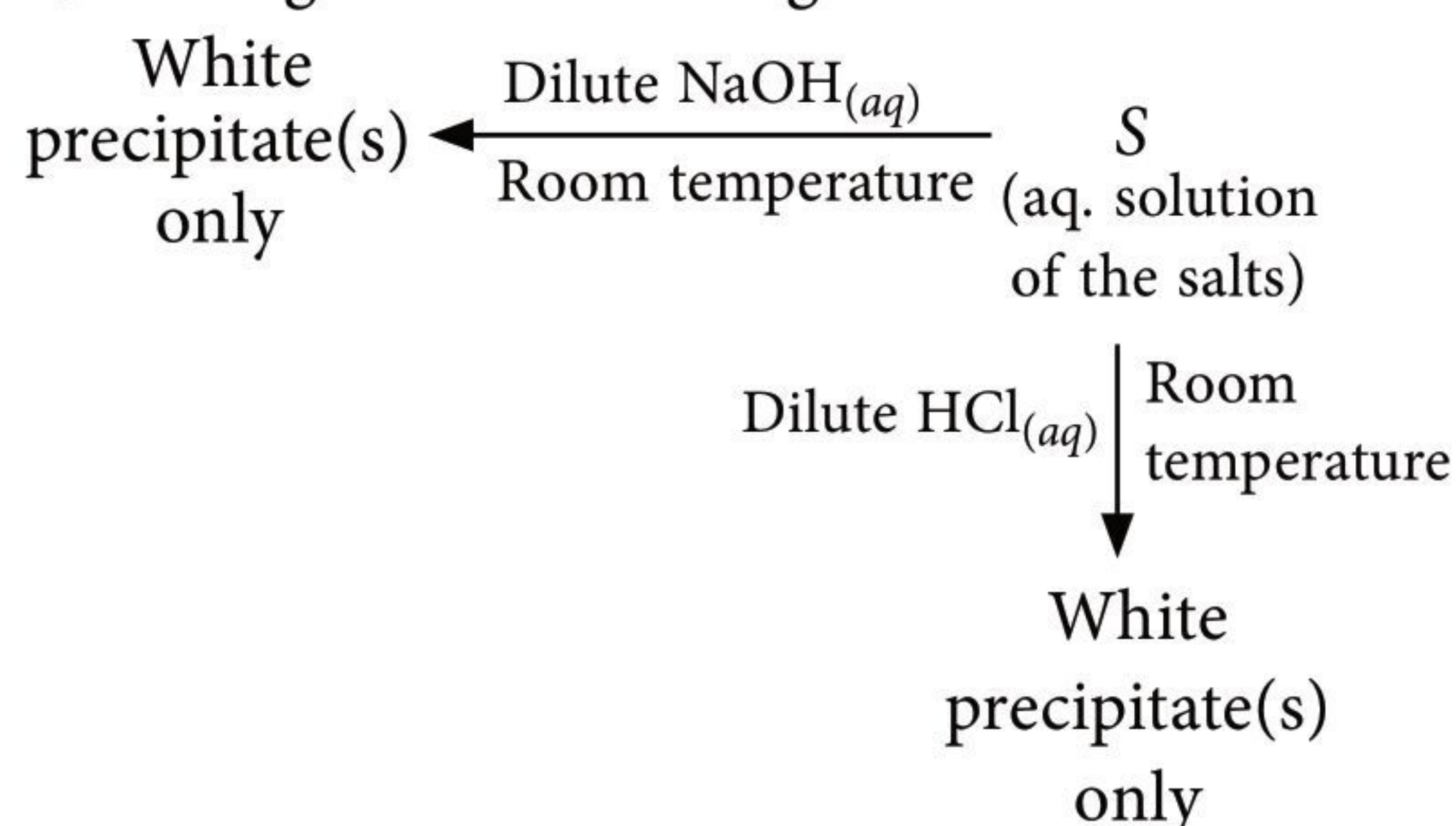
(P: pressure, V: volume, T: temperature, H: enthalpy, S: entropy)



15. The correct statement(s) related to the metal extraction processes is(are)

- a mixture of PbS and PbO undergoes self-reduction to produce Pb and SO_2
- in the extraction process of copper from copper pyrites, silica is added to produce copper silicate
- partial oxidation of sulphide ore of copper by roasting, followed by self-reduction produces blister copper
- in cyanide process, zinc powder is utilized to precipitate gold from $\text{Na}[\text{Au}(\text{CN})_2]$.

16. A mixture of two salts is used to prepare a solution S, which gives the following results.



The correct option(s) for the salt mixture is(are)

- $\text{Pb}(\text{NO}_3)_2$ and $\text{Zn}(\text{NO}_3)_2$
- $\text{Pb}(\text{NO}_3)_2$ and $\text{Bi}(\text{NO}_3)_3$
- AgNO_3 and $\text{Bi}(\text{NO}_3)_3$
- $\text{Pb}(\text{NO}_3)_2$ and $\text{Hg}(\text{NO}_3)_2$

SECTION 4

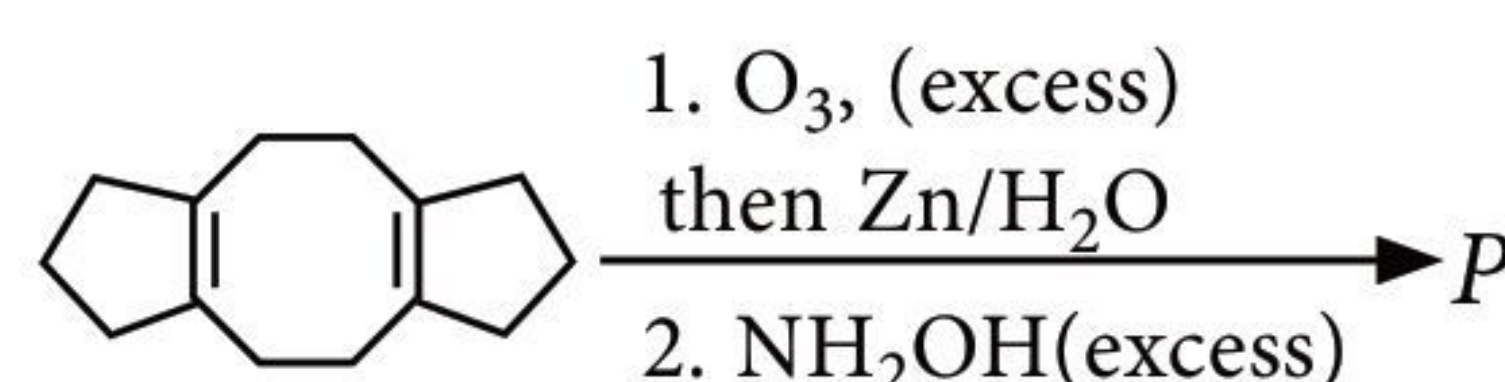
- This section contains **THREE (03)** questions.
- The answer to each question is a **NON-NEGATIVE INTEGER**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If **ONLY** the correct integer is entered;

Zero Marks : 0 In all other cases.

17. The maximum number of possible isomers (including stereoisomers) which may be formed on mono-bromination of 1-methylcyclohex-1-ene using Br_2 and UV light is _____.

18. In the reaction given below, the total number of atoms having sp^2 hybridization in the major product **P** is _____.



19. The total number of possible isomers for $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]\text{Br}_2$ is _____.

PAPER - II

SECTION 1

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (a), (b), (c) and (d). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is(are) chosen;

Partial Marks : +3 If all the four options are correct but **ONLY** three options are chosen;

Partial Marks : +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct;

Partial Marks : +1 If two or more options are correct but **ONLY** one option is chosen and it is a correct option;

Zero Marks : 0 If unanswered;

Negative Marks : -2 In all other cases.

For example, in a question, if (a), (b) and (d) are the **ONLY** three options corresponding to correct answers, then

choosing **ONLY** (a), (b) and (d) will get +4 marks;

choosing **ONLY** (a) and (b) will get +2 marks;

choosing **ONLY** (a) and (d) will get +2 marks;

choosing **ONLY** (b) and (d) will get +2 marks;

choosing **ONLY** (a) will get +1 mark;

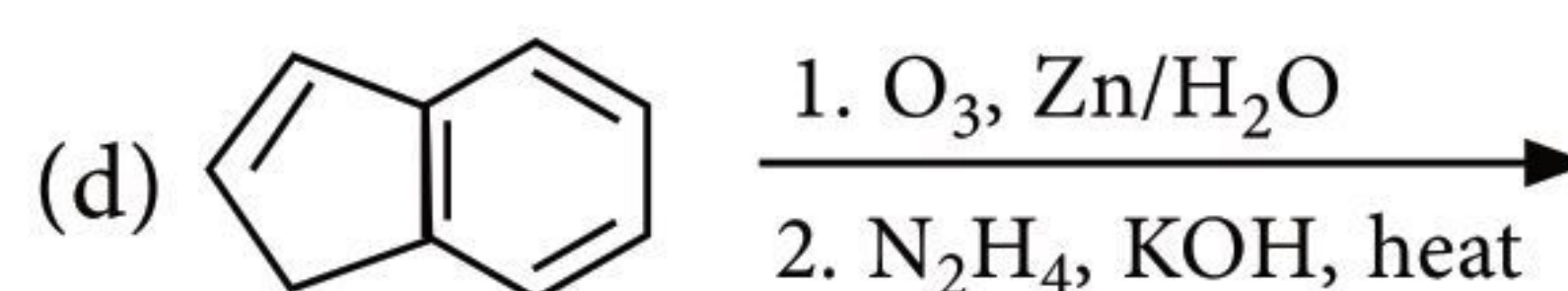
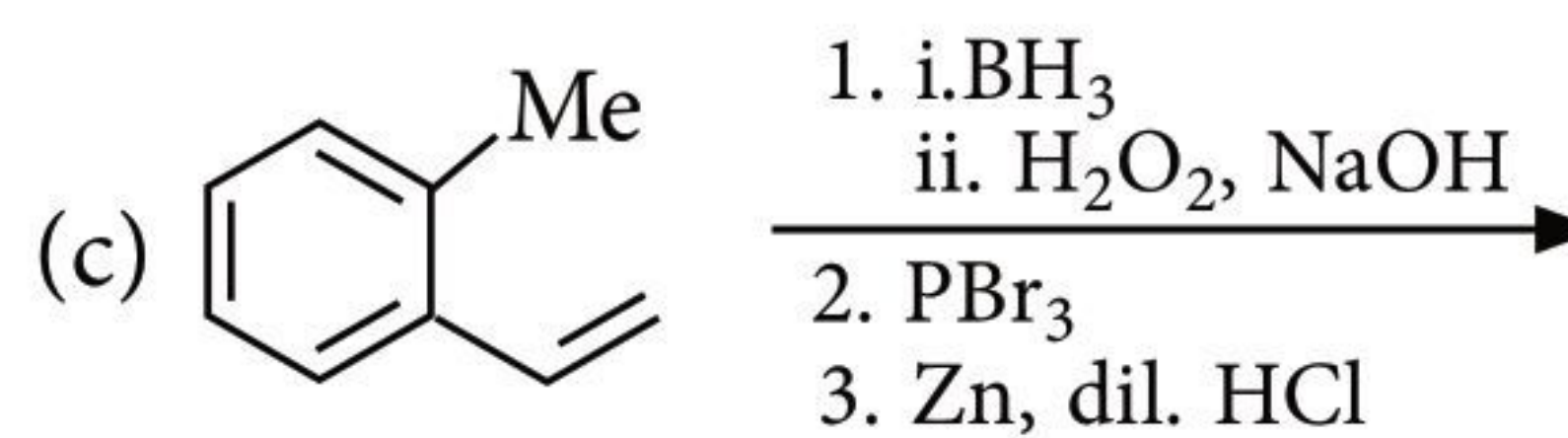
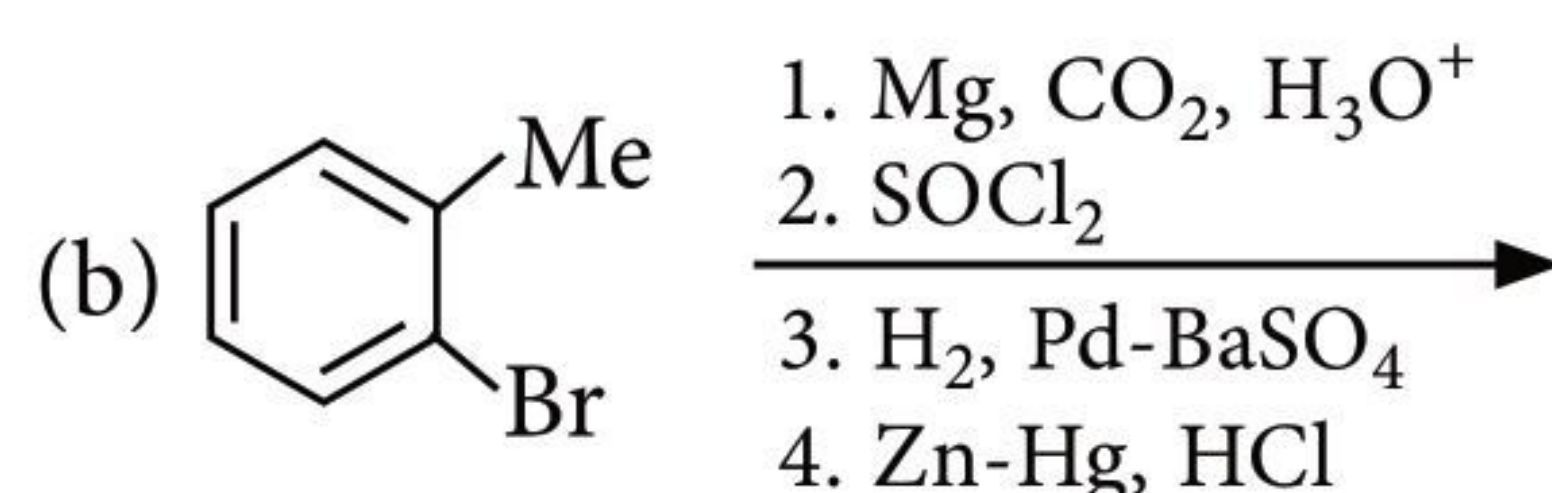
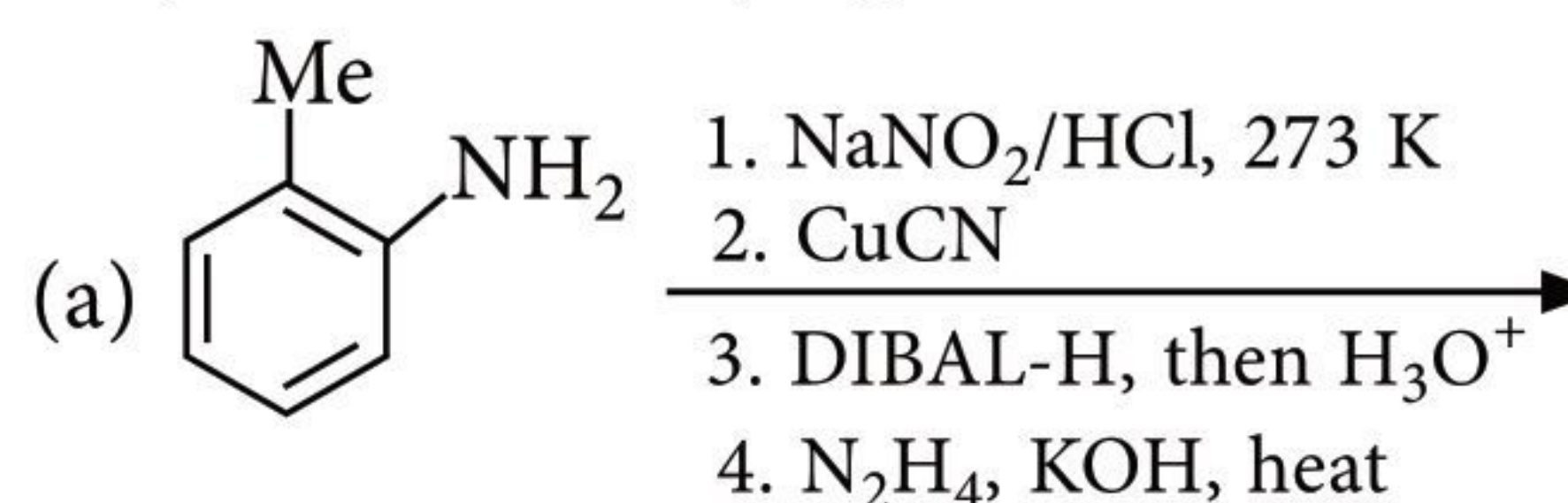
choosing **ONLY** (b) will get +1 mark;

choosing **ONLY** (d) will get +1 mark;

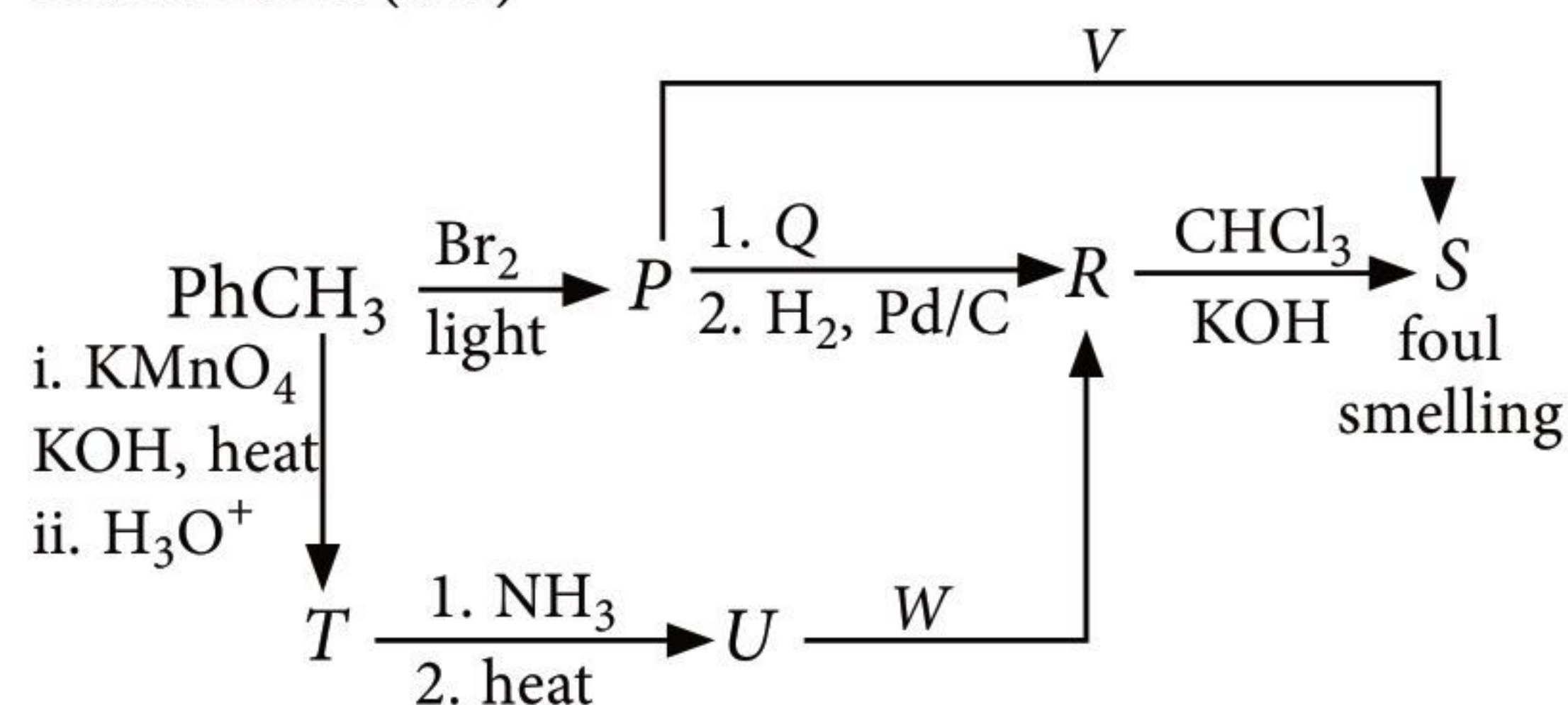
choosing no option(s) (i.e. the question is unanswered) will get 0 marks and

choosing any other option(s) will get -2 marks.

1. The reaction sequence(s) that would lead to *o*-xylene as the major product is(are)



2. Correct option(s) for the following sequence of reactions is(are)



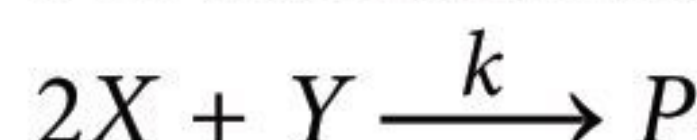
(a) $\text{Q} = \text{KNO}_2$, $\text{W} = \text{LiAlH}_4$

(b) $\text{R} = \text{benzenamine}$, $\text{V} = \text{KCN}$

(c) $\text{Q} = \text{AgNO}_2$, $\text{R} = \text{phenylmethanamine}$

(d) $\text{W} = \text{LiAlH}_4$, $\text{V} = \text{AgCN}$

3. For the following reaction



the rate of reaction is $\frac{d[P]}{dt} = k[X]$. Two moles of

X are mixed with one mole of Y to make 1.0 L of solution. At 50 s, 0.5 mole of Y is left in the reaction mixture. The correct statement(s) about the reaction is(are)

(Use: $\ln 2 = 0.693$)

(a) the rate constant, k , of the reaction is $13.86 \times 10^{-4} \text{ s}^{-1}$

(b) half-life of X is 50 s

(c) at 50 s, $-\frac{d[X]}{dt} = 13.86 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$

(d) at 100 s, $-\frac{d[Y]}{dt} = 3.46 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$

4. Some standard electrode potentials at 298 K are given below :

Pb^{2+}/Pb -0.13 V

Ni^{2+}/Ni -0.24 V

Cd^{2+}/Cd -0.40 V

Fe^{2+}/Fe -0.44 V

To a solution containing 0.001 M of X^{2+} and 0.1 M of Y^{2+} , the metal rods X and Y are inserted (at 298 K) and connected by a conducting wire. This resulted in dissolution of X. The correct combination(s) of X and Y, respectively, is(are)

(Given: Gas constant, $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$, Faraday constant, $F = 96500 \text{ C mol}^{-1}$)

- (a) Cd and Ni (b) Cd and Fe
(c) Ni and Pb (d) Ni and Fe

5. The pair(s) of complexes wherein both exhibit tetrahedral geometry is(are)

(Note: py = pyridine)

Given: Atomic numbers of Fe, Co, Ni and Cu are 26, 27, 28 and 29, respectively)

- (a) $[\text{FeCl}_4]^-$ and $[\text{Fe}(\text{CO})_4]^{2-}$
(b) $[\text{Co}(\text{CO})_4]^-$ and $[\text{CoCl}_4]^{2-}$
(c) $[\text{Ni}(\text{CO})_4]$ and $[\text{Ni}(\text{CN})_4]^{2-}$
(d) $[\text{Cu}(\text{py})_4]^+$ and $[\text{Cu}(\text{CN})_4]^{3-}$

6. The correct statement(s) related to oxoacids of phosphorous is(are)

- (a) upon heating, H_3PO_3 undergoes disproportionation reaction to produce H_3PO_4 and PH_3
(b) while H_3PO_3 can act as reducing agent, H_3PO_4 cannot
(c) H_3PO_3 is a monobasic acid
(d) the H atom of P—H bond in H_3PO_3 is not ionizable in water.

SECTION 2

- This section contains **THREE (03)** question stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +2 If **ONLY** the correct numerical value is entered at the designated place;

Zero Marks : 0 In all other cases.

Question Stem for Question Nos. 7 and 8

Question Stem

At 298 K, the limiting molar conductivity of a weak monobasic acid is $4 \times 10^2 \text{ S cm}^2 \text{ mol}^{-1}$. At 298 K, for an aqueous solution of the acid the degree of dissociation is α and the molar conductivity is $y \times 10^2 \text{ S cm}^2 \text{ mol}^{-1}$. At 298 K, upon 20 times dilution with water, the molar conductivity of the solution becomes $3y \times 10^2 \text{ S cm}^2 \text{ mol}^{-1}$.

7. The value of α is ____.

8. The value of y is ____.

Question Stem for Question Nos. 9 and 10

Question Stem

Reaction of x g of Sn with HCl quantitatively produced a salt. Entire amount of the salt reacted with y g of nitrobenzene in the presence of required amount of HCl to produce 1.29 g of an organic salt (quantitatively). (Use Molar masses (in g mol^{-1}) of H, C, N, O, Cl and Sn as 1, 12, 14, 16, 35 and 119, respectively).

9. The value of x is ____.

10. The value of y is ____.

Question Stem for Question Nos. 11 and 12

Question Stem

A sample (5.6 g) containing iron is completely dissolved in cold dilute HCl to prepare a 250 mL of solution. Titration of 25.0 mL of this solution requires 12.5 mL of 0.03 M KMnO_4 solution to reach the end point. Number of moles of Fe^{2+} present in 250 mL solution is $x \times 10^{-2}$ (consider complete dissolution of FeCl_2). The

amount of iron present in the sample is $y\%$ by weight.
(Assume: KMnO_4 reacts only with Fe^{2+} in the solution
Use: Molar mass of iron as 56 g mol^{-1})

11. The value of x is _____.

12. The value of y is _____.

SECTION 3

- This section contains TWO (02) paragraphs. Based on each paragraph, there are TWO (02) questions.
- Each question has FOUR options (a), (b), (c) and (d). ONLY ONE of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

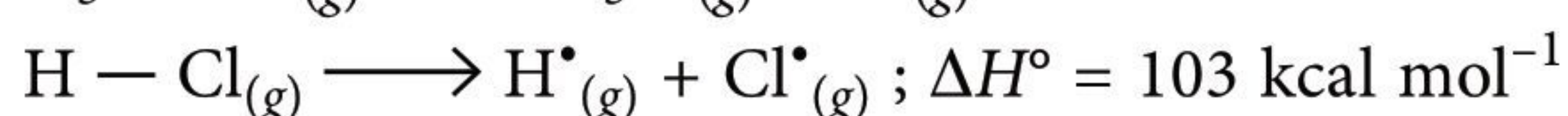
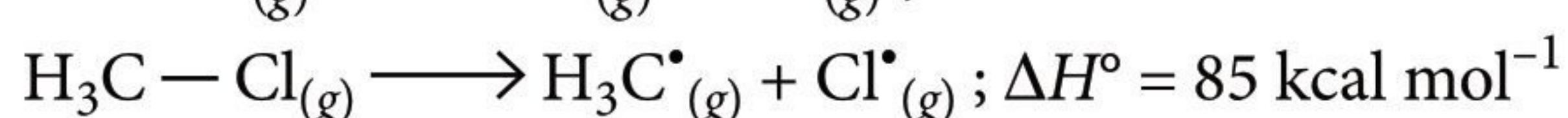
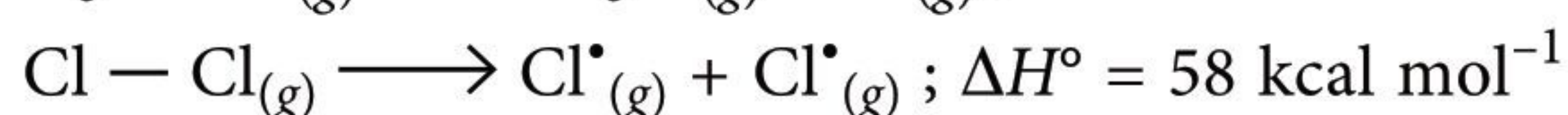
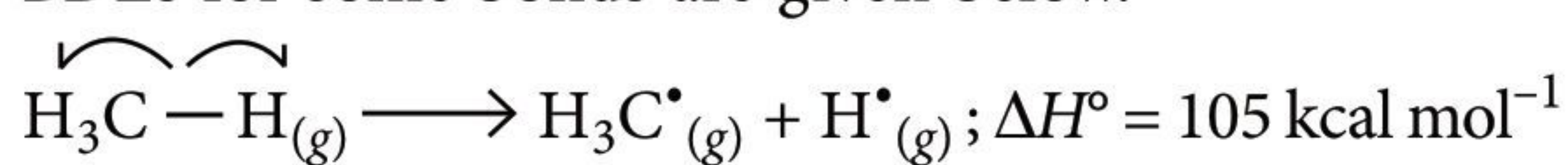
Full Marks : +3 If ONLY the correct option is chosen;

Zero Marks : 0 If none of the options is chosen (i.e., the question is unanswered);

Negative Marks : -1 In all other cases.

Paragraph-1

The amount of energy required to break a bond is same as the amount of energy released when the same bond is formed. In gaseous state, the energy required for homolytic cleavage of a bond is called Bond Dissociation Energy (BDE) or Bond Strength. BDE is affected by s -character of the bond and the stability of the radicals formed. Shorter bonds are typically stronger bonds. BDEs for some bonds are given below.

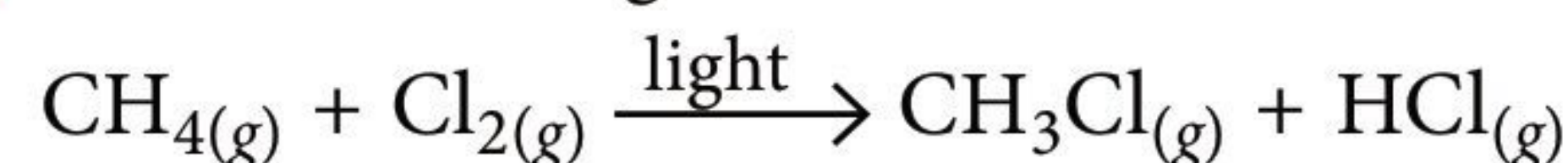


13. Correct match of the C — H bonds (shown in bold) in Column J with their BDE in Column K is

Column J Molecule		Column K BDE (kcal mol^{-1})	
(P)	H — $\text{CH}(\text{CH}_3)_2$	(i)	132
(Q)	H — CH_2Ph	(ii)	110
(R)	H — $\text{CH}=\text{CH}_2$	(iii)	95
(S)	H — $\text{C}\equiv\text{CH}$	(iv)	88

- (a) P — iii, Q — iv, R — ii, S — i
(b) P — i, Q — ii, R — iii, S — iv
(c) P — iii, Q — ii, R — i, S — iv
(d) P — ii, Q — i, R — iv, S — iii

14. For the following reaction



the correct statement is

- (a) initiation step is exothermic with $\Delta H^\circ = -58 \text{ kcal mol}^{-1}$.
(b) propagation step involving $\cdot\text{CH}_3$ formation is exothermic with $\Delta H^\circ = -2 \text{ kcal mol}^{-1}$
(c) propagation step involving CH_3Cl formation is endothermic with $\Delta H^\circ = +27 \text{ kcal mol}^{-1}$
(d) the reaction is exothermic with $\Delta H^\circ = -25 \text{ kcal mol}^{-1}$.

Paragraph-2

The reaction of $\text{K}_3[\text{Fe}(\text{CN})_6]$ with freshly prepared FeSO_4 solution produces a dark blue precipitate called Turnbull's blue. Reaction of $\text{K}_4[\text{Fe}(\text{CN})_6]$ with the FeSO_4 solution in complete absence of air produces a white precipitate X, which turns blue in air. Mixing the FeSO_4 solution with NaNO_3 , followed by a slow addition of concentrated H_2SO_4 through the side of the test tube produces a brown ring.

15. Precipitate X is

- (a) $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$ (b) $\text{Fe}[\text{Fe}(\text{CN})_6]$
(c) $\text{K}_2\text{Fe}[\text{Fe}(\text{CN})_6]$ (d) $\text{KFe}[\text{Fe}(\text{CN})_6]$

16. Among the following, the brown ring is due to the formation of

- (a) $[\text{Fe}(\text{NO})_2(\text{SO}_4)_2]^{2-}$ (b) $[\text{Fe}(\text{NO})_2(\text{H}_2\text{O})_4]^{3+}$
(c) $[\text{Fe}(\text{NO})_4(\text{SO}_4)_2]$ (d) $[\text{Fe}(\text{NO})(\text{H}_2\text{O})_5]^{2+}$

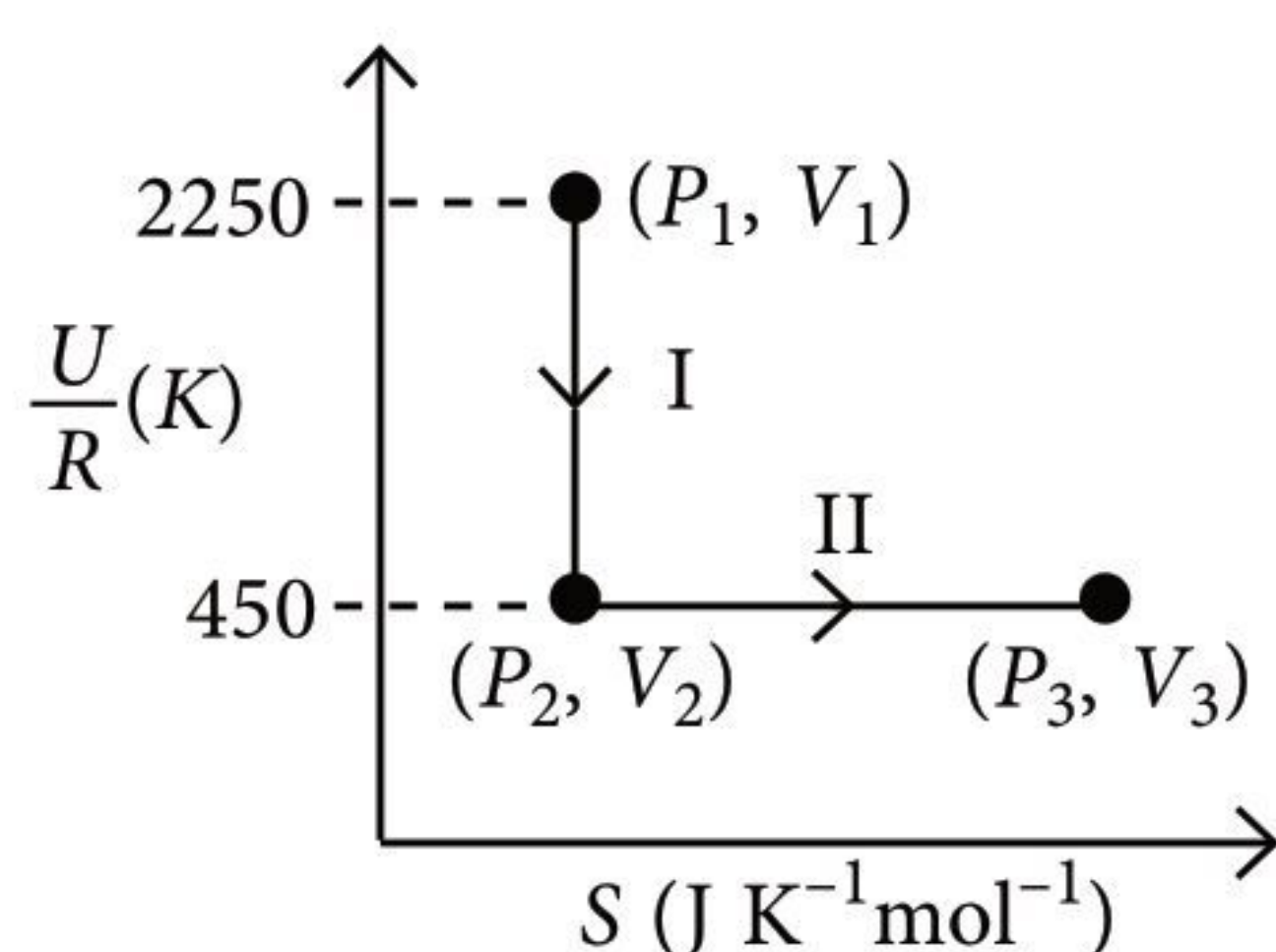
SECTION 4

- This section contains THREE (03) questions.
- The answer to each question is a NON-NEGATIVE INTEGER.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If ONLY the correct integer is entered;

Zero Marks : 0 In all other cases.

17. One mole of an ideal gas at 900 K, undergoes two reversible processes, I followed by II, as shown below. If the work done by the gas in the two processes are same, the value of $\ln \frac{V_3}{V_2}$ is ____.



(U : internal energy, S : entropy, P : pressure, V : volume, R : gas constant)

(Given: molar heat capacity at constant volume, $C_{V,m}$ of the gas is $\frac{5}{2}R$.)

18. Consider a helium (He) atom that absorbs a photon of wavelength 330 nm. The change in the velocity (in cm s^{-1}) of He atom after the photon absorption is ____.

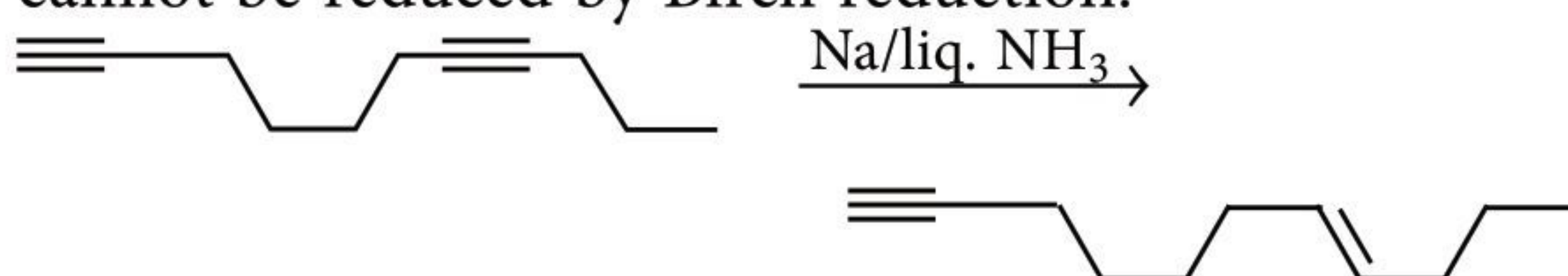
(Assume: Momentum is conserved when photon is absorbed. Use: Planck constant = 6.6×10^{-34} J s, Avogadro number = $6 \times 10^{23} \text{ mol}^{-1}$, Molar mass of He = 4 g mol^{-1})

19. Ozonolysis of ClO_2 produces an oxide of chlorine. The average oxidation state of chlorine in this oxide is ____.

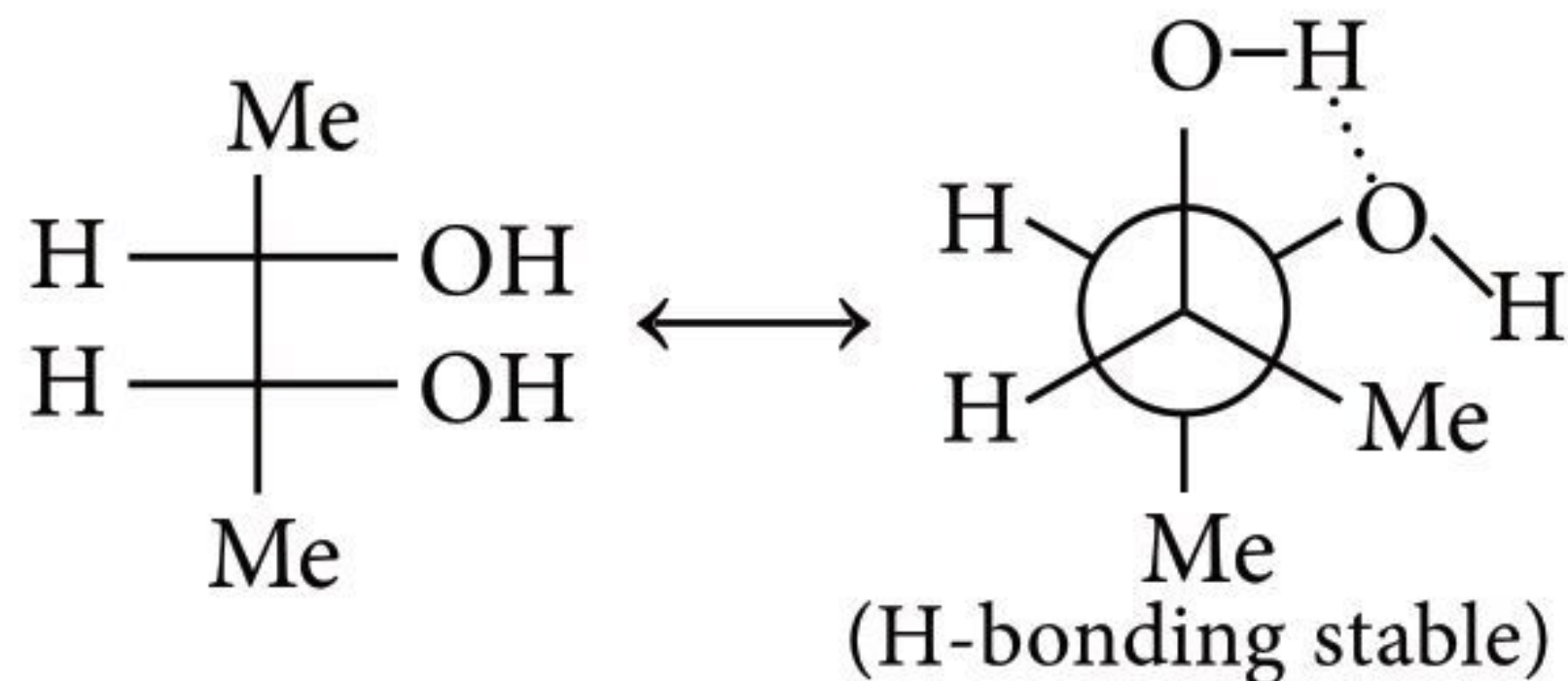
SOLUTIONS

PAPER - I

1. (b): *Trans* addition of H_2 takes place with Na/liq. NH_3 . i.e., Birch reduction, but terminal alkynes cannot be reduced by Birch reduction.



2. (b): Compounds given in options *c* and *d* are not meso forms. Compounds given in options *a* and *b* are meso forms out of which *b* is stable due to H-bonding.



3. (b): For a square planar structure

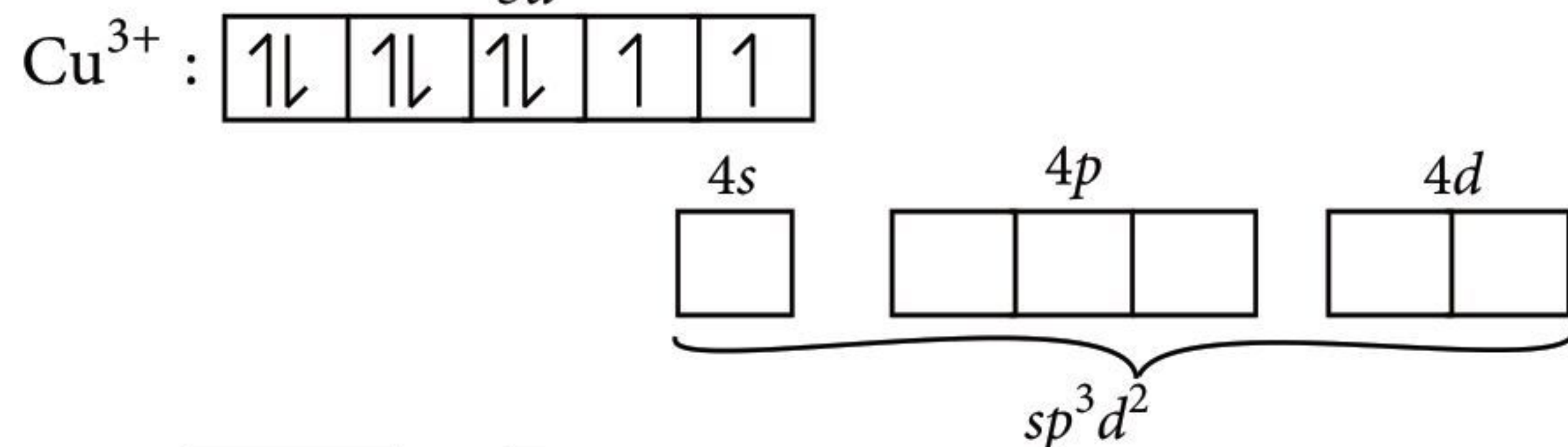
$$\frac{r_+}{r_-} = 0.414 \text{ or } a = 2r_-$$

$$\text{P.F.} = \frac{1 \times \frac{4}{3} \pi r_-^3 + 3 \times \frac{4}{3} \pi r_+^3}{a^3} = \frac{\frac{4}{3} \pi (r_-^3 + 3r_+^3)}{8r_-^3}$$

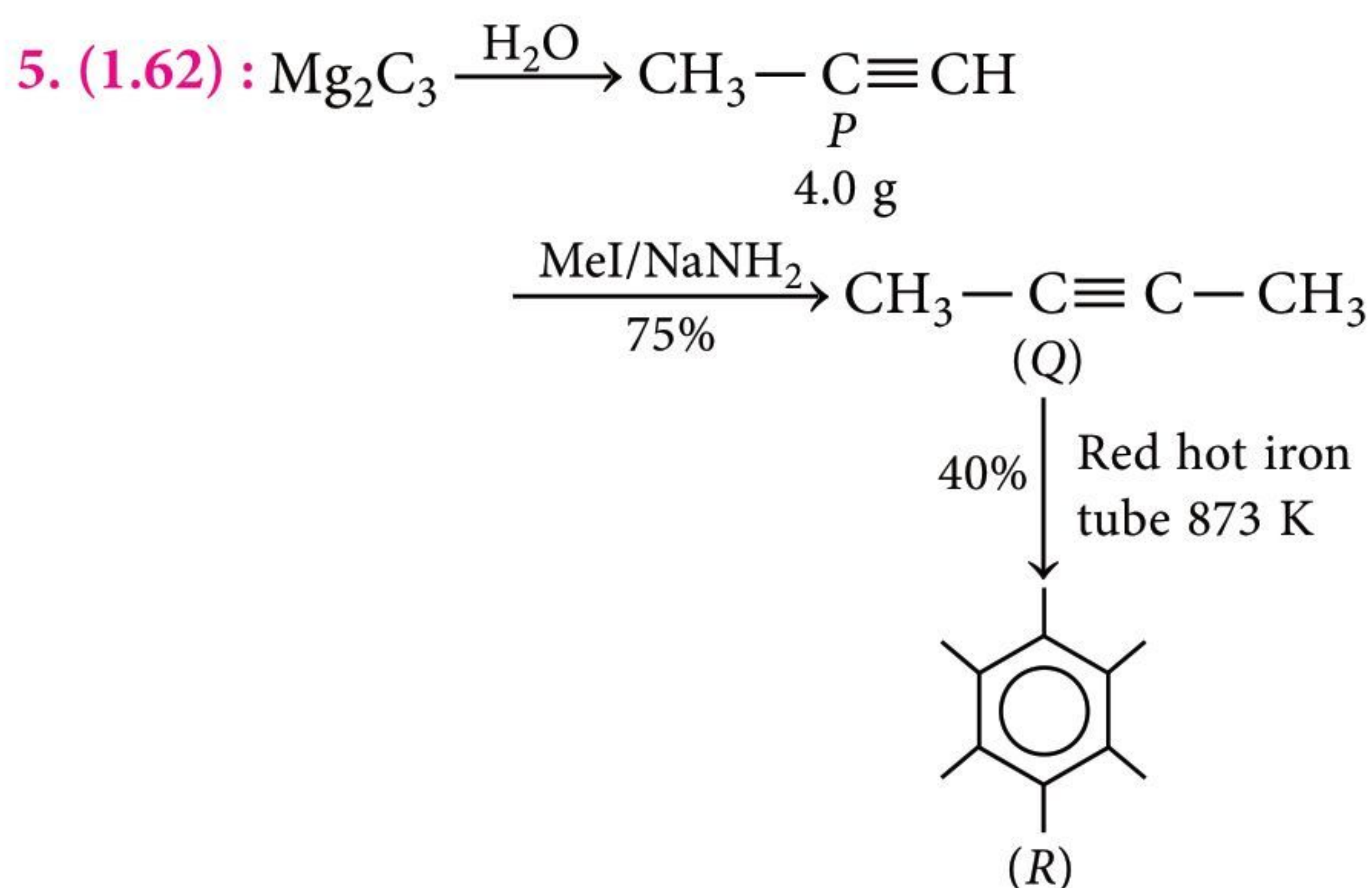
$$= \frac{\pi}{6} (1 + 3(0.414)^3) = 0.63$$

4. (a): $\text{Cr}^{3+} \Rightarrow [\text{Ar}]3d^3$; strong field $t_{2g}^3 e_g^0$
 $\mu = \sqrt{3(3+2)} = \sqrt{15} = 3.87$ B.M. $d^2 sp^3$ hybridisation

$\text{Cu}^{3+} \Rightarrow [\text{Ar}]3d^8$; weak field $t_{2g}^6 e_g^2$



$$\mu = \sqrt{2(2+2)} = \sqrt{8} = 2.83 \text{ B.M.}$$



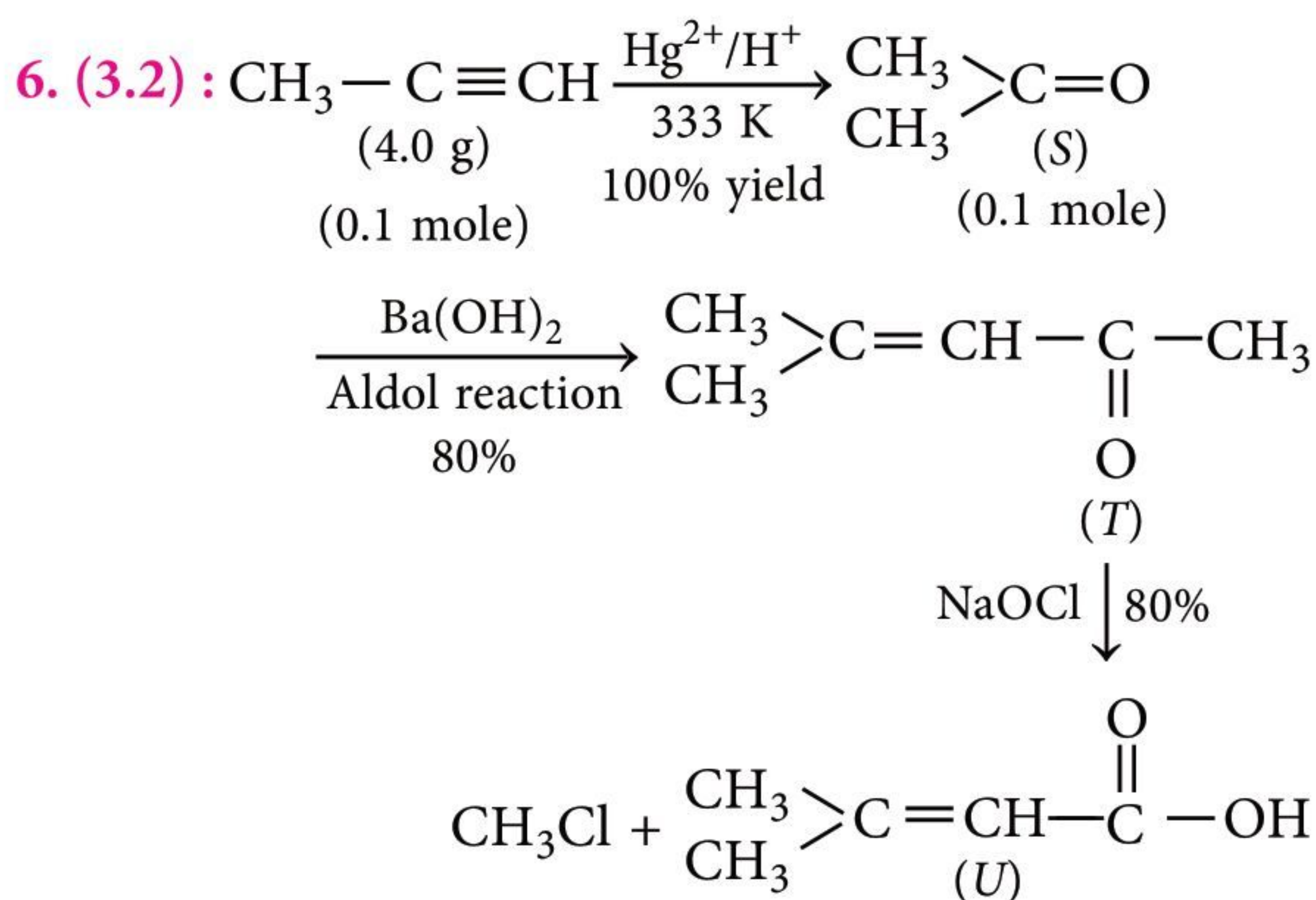
1 mole of $\text{CH}_3\text{C}\equiv\text{CH}$ gives 0.75 mole of 2-butyne as yield is 75% only.

Here we have only 0.1 mole (4 g) of propyne so, 2-butyne produced = 0.075 mole

3 moles of 2-butyne produces 0.4 mole of R
 0.075 moles 2-butyne produces

$$= 0.4 \times 0.075 \times \frac{1}{3} = 0.01 \text{ moles}$$

Mass of R = $0.01 \times 162 = 1.62 \text{ g}$



$$\text{Moles of } T = 0.1 \times \frac{80}{100} \times \frac{1}{2}$$

$$\text{Moles of } U = 0.1 \times \frac{80}{100} \times \frac{1}{2} \times \frac{80}{100} = 0.032 \text{ mole}$$

Moles of U produced = 0.032 mole

Mass of U produced = $0.032 \times 100 = 3.2 \text{ g}$

7. (-166.28) : From the equation

$$\frac{d(\ln K)}{d\left(\frac{1}{T}\right)} = -\frac{\Delta H^\circ}{R}$$

We can say that, for the curve between $d(\ln K)$ and

$$d\left(\frac{1}{T}\right),$$

$$\text{Slope} = -\frac{\Delta H^\circ}{R} = 10^4 \left(\frac{4}{2}\right)$$

$$\Delta H^\circ = -2 \times 10^4 \times R = -2 \times 8.314 \times 10^4$$

$$= -166.28 \text{ kJ/mole}$$

8. (141.34) : $\Delta G^\circ = -RT \ln K = \Delta H^\circ - T\Delta S^\circ$

$$\Rightarrow -RT \ln \left(\frac{p_Z}{p^\circ}\right) = \Delta H^\circ - T\Delta S^\circ$$

$$\text{or } \ln \frac{p_Z}{p^\circ} = -\frac{\Delta H^\circ}{RT} + \frac{\Delta S^\circ}{R} \quad \dots(i)$$

For the curve where

$$\frac{10^4}{T} = 10 \quad \text{and} \quad \ln \frac{p_Z}{p^\circ} = -3$$

Putting the value in equation (i) we get,

$$-3 = -\frac{166.28 \times 1000}{R \times 1000} + \frac{\Delta S^\circ}{R}$$

$$-3 = \frac{1}{R} (\Delta S^\circ - 166.28)$$

$$-3R = \Delta S^\circ - 166.28$$

$$\Delta S^\circ = 166.28 - 3R = 141.338 \text{ J K}^{-1} \text{ mol}^{-1}$$

9. (100.1) : Molality(m) = 0.1 molal

B.P. = $x^\circ \text{C}$

Solute = AgNO_3 for solution A

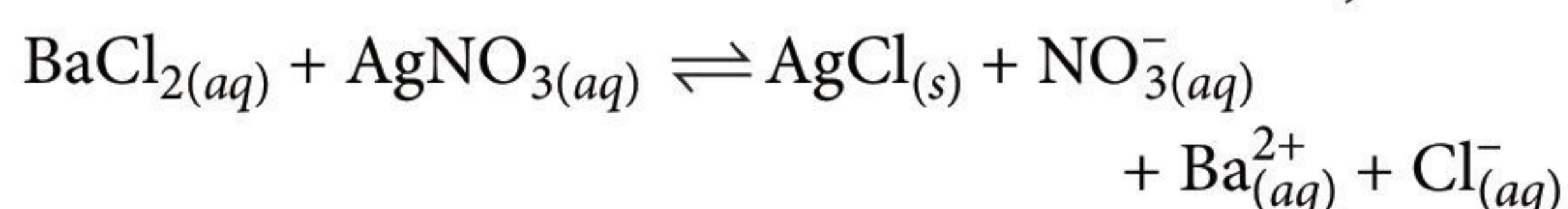
$$\Delta T_b = iK_b m; \quad i = 2$$

$$\Delta T_b = 2 \times 0.5 \times 0.1; \quad K_b = 0.5 \text{ K kg mol}^{-1}$$

$$= 0.1^\circ \text{C}$$

$$T_b = 100 + 0.1 = 100.1^\circ \text{C}$$

10. (2.5) : On adding BaCl_2 (0.1 m) to AgNO_3 (0.1 m) volume doubles so concentration becomes half i.e., 0.05 m.



Molality (m) = 0.05

$i = 3$

$$K_b = 0.5 \text{ K kg}^{-1} \text{ mol}^{-1}$$

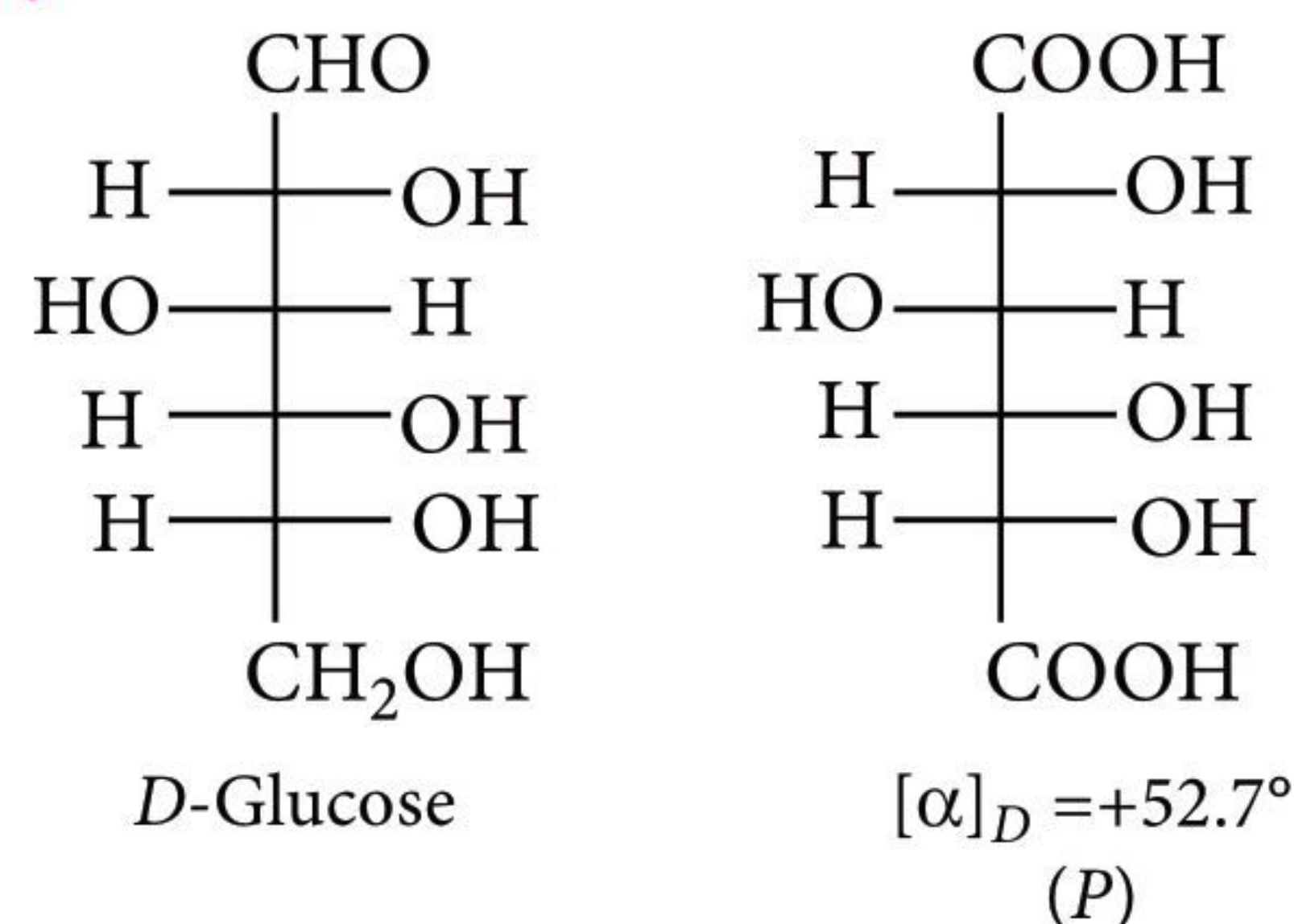
$$\Delta T_b = 3 \times 0.05 \times 0.5 = 0.075 \text{ K or } ^\circ \text{C}$$

$$T_b = 100 + 0.075 = 100.075^\circ \text{C}$$

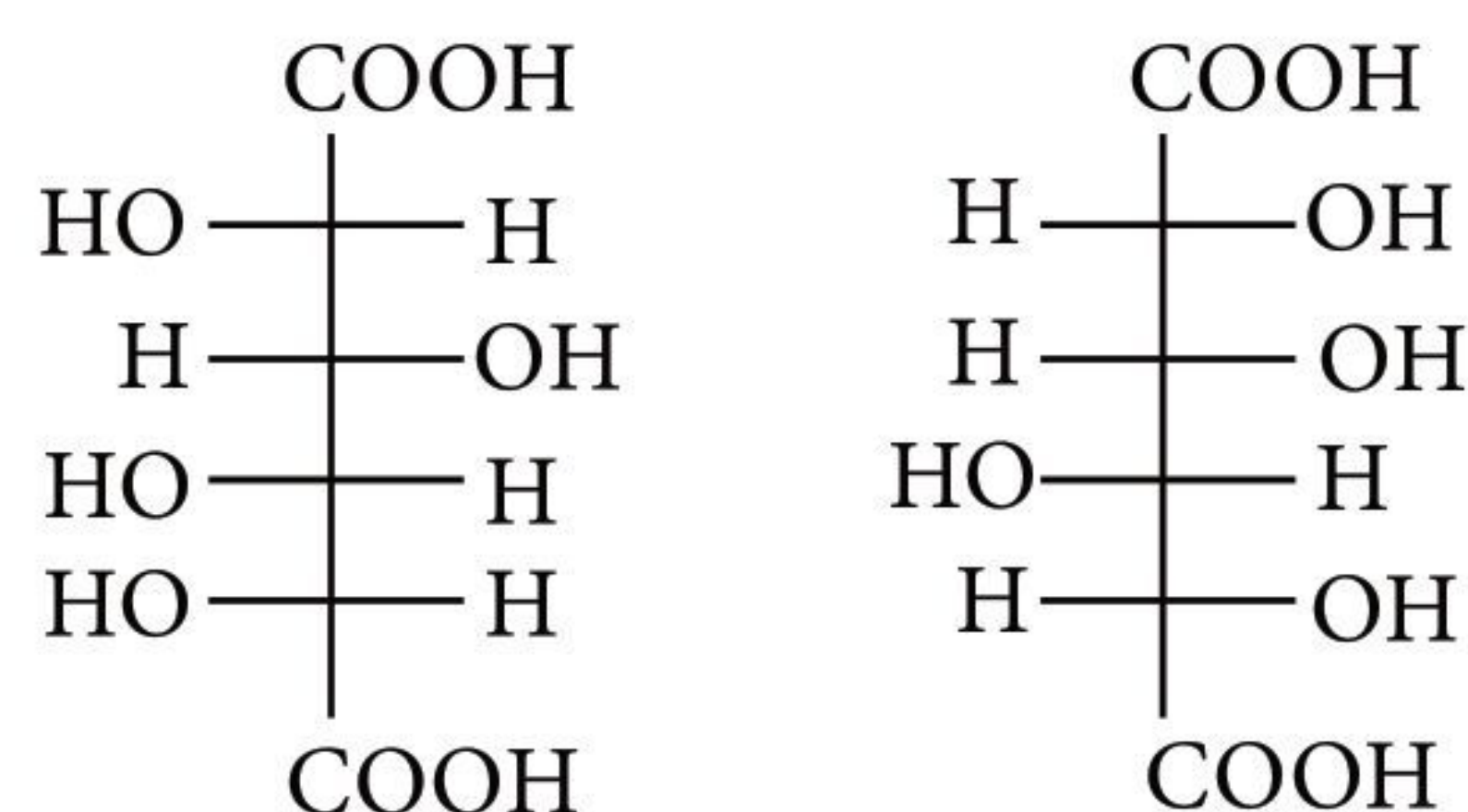
$$\text{Difference in B.P.}(y) = 100.1 - 100.075$$

$$= 0.025 \text{ or } 2.5 \times 10^{-2}^\circ \text{C}$$

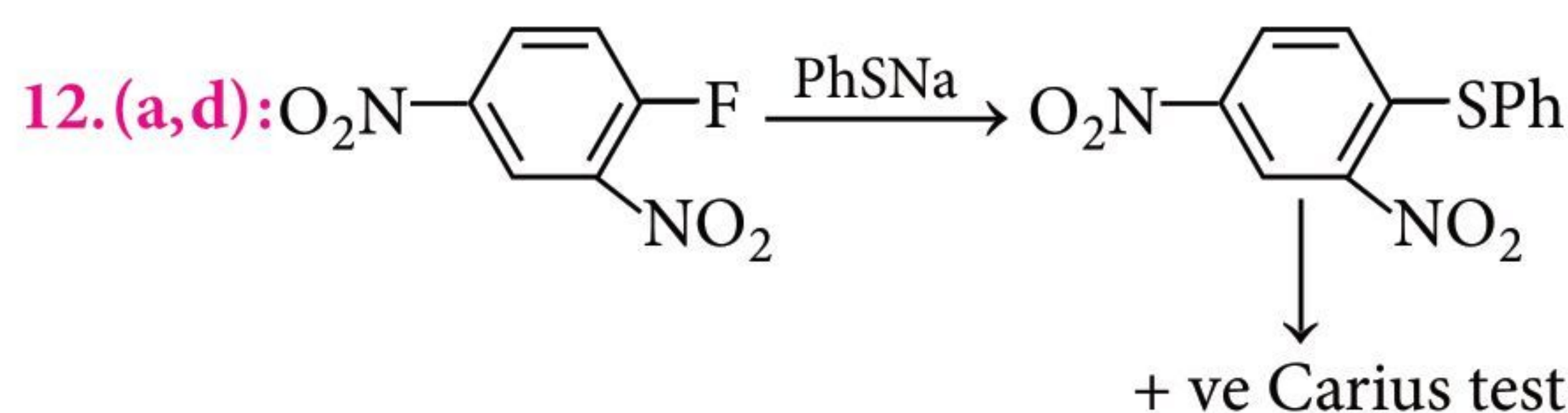
11. (c, d) :



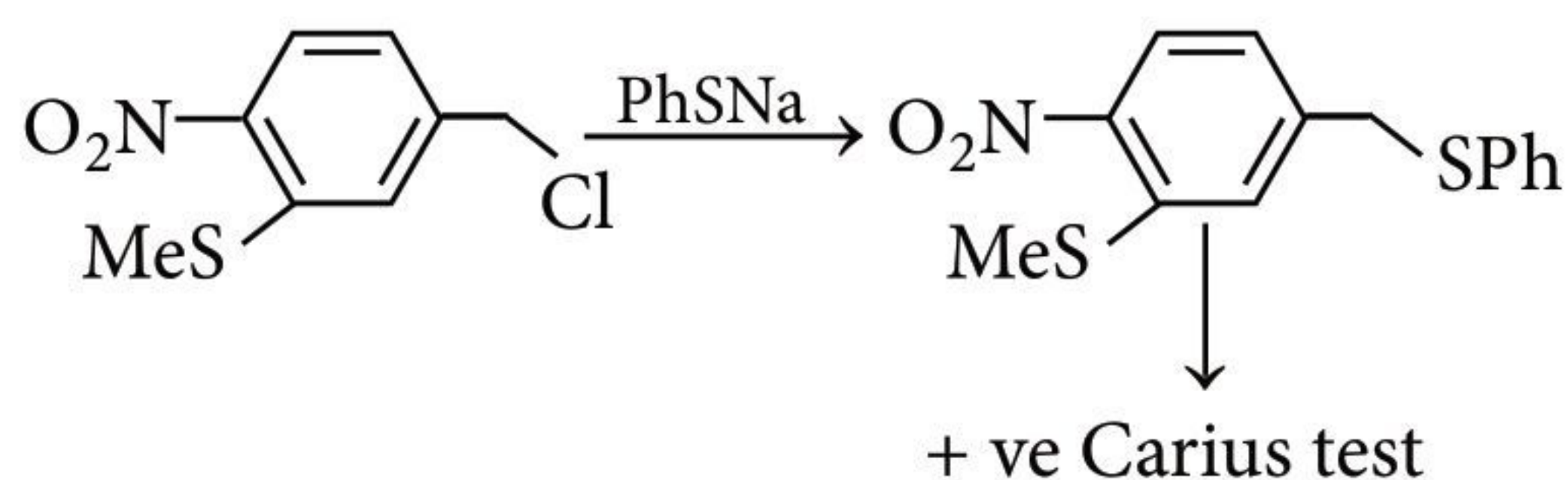
Enantiomers of P will show degree of rotation $[\alpha]_D = -52.7^\circ$, which will have the following two possible structures.



These two can be obtained by oxidation of C and D respectively.



The given compound give positive carius test due to presence of two EWG ($-\text{NO}_2$) at $-o$ and $-p$ position.



13. (b, c) : The process of formation or conversion of a precipitate into a colloidal solution is called peptization. Due to bigger aggregates, the number of particles in a colloidal solution is comparatively small as compared to a true solution. Hence, the values of the colligative properties observed experimentally are very small as

compared to values shown by true solutions of same concentrations. Depression in freezing point is small in colloidal solutions hence it will freeze at higher temperature.

Micelles are formed above CMC and it depends on temperature. Micelles are associated colloids.

14. (a, b, d): Isothermal expansion : (I to II)

T – constant

V – Increase, So, P – decrease

$\Delta T = 0$ so, $\Delta H = 0$ i.e., H – constant

As its expansion so, S – increases

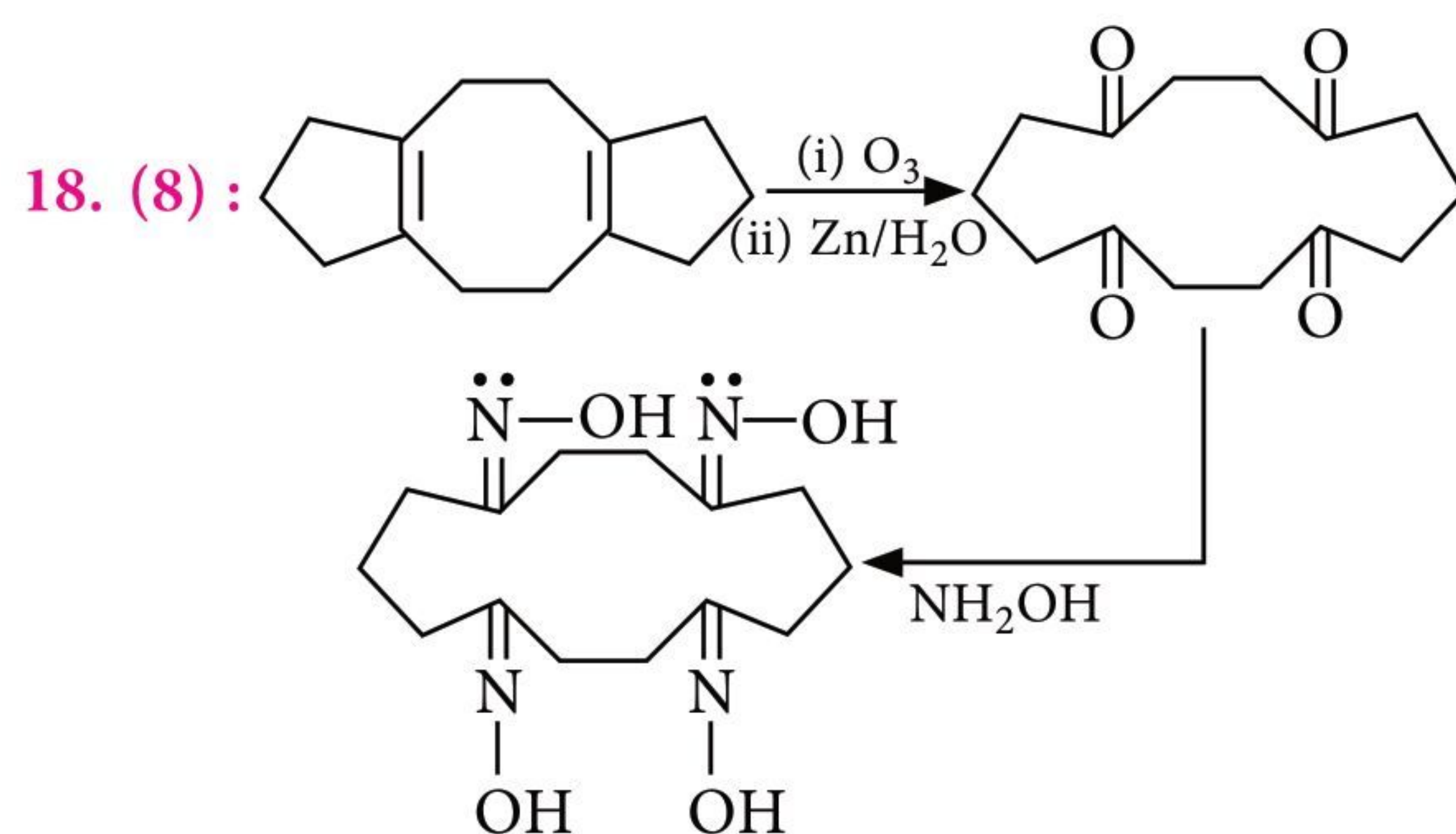
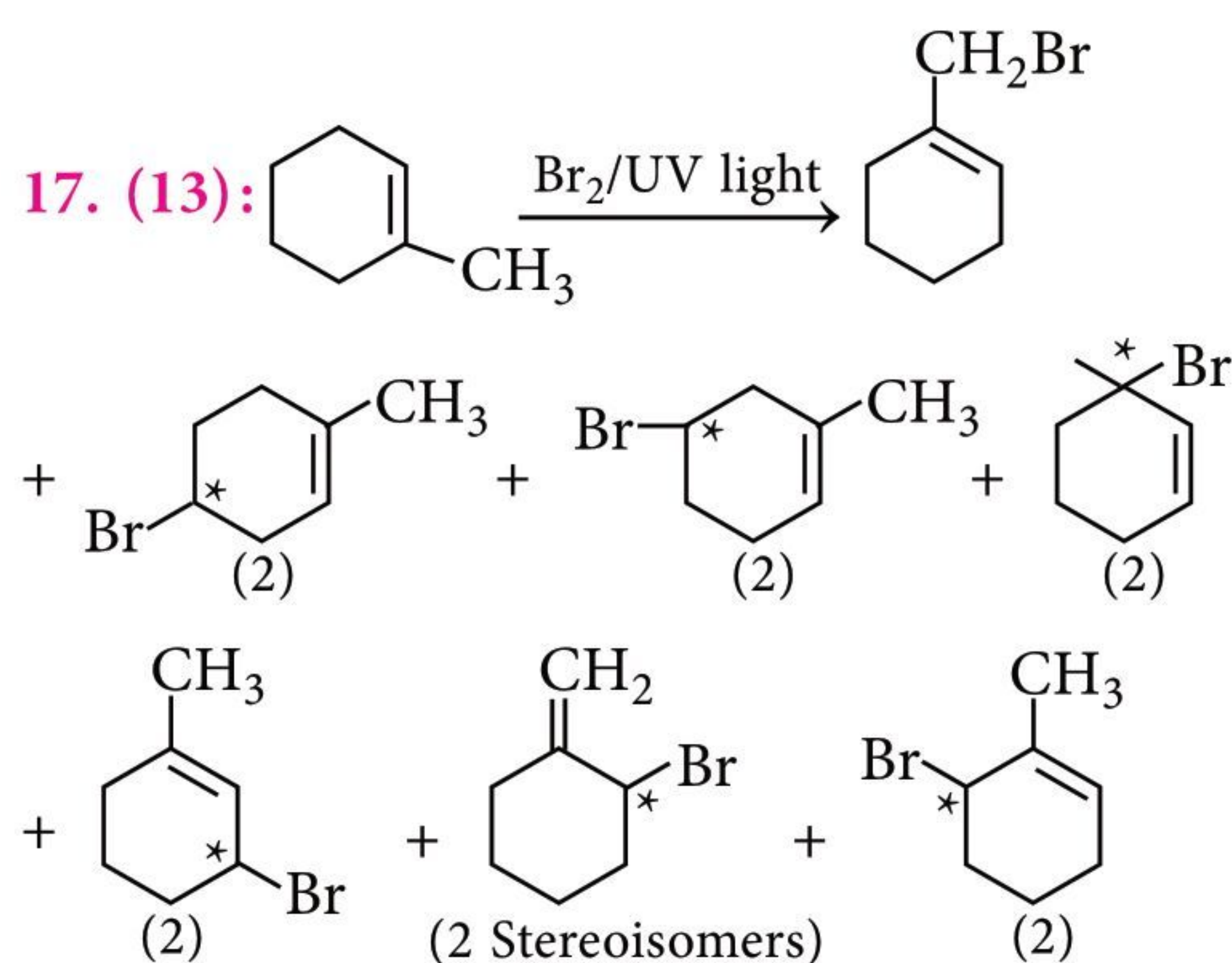
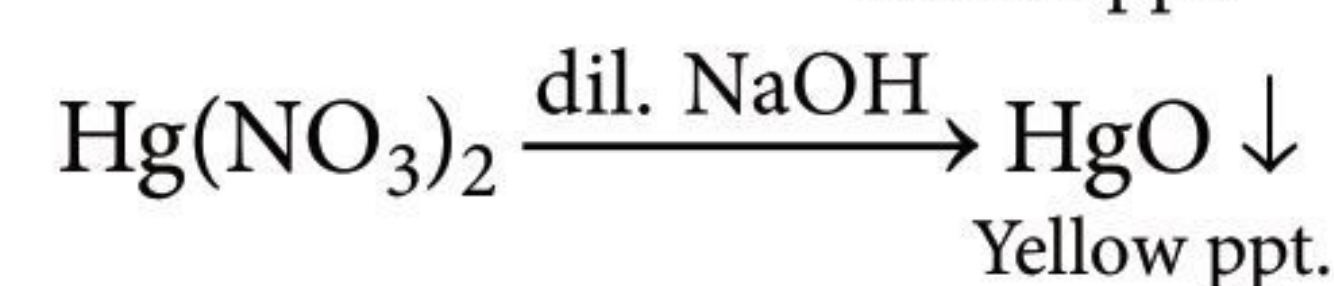
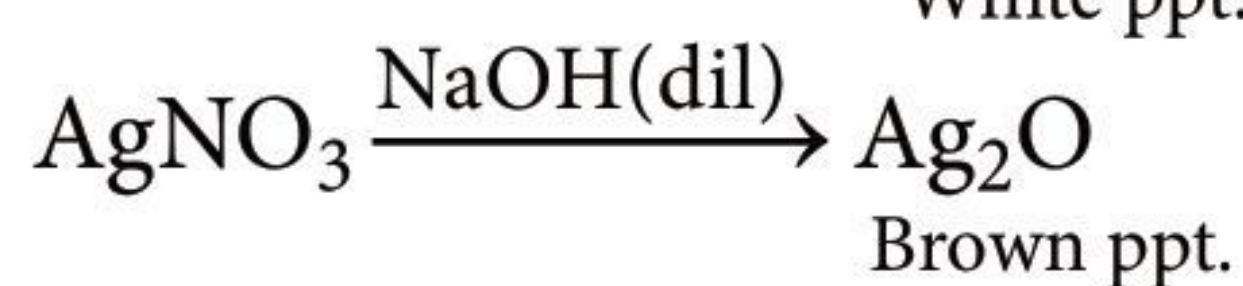
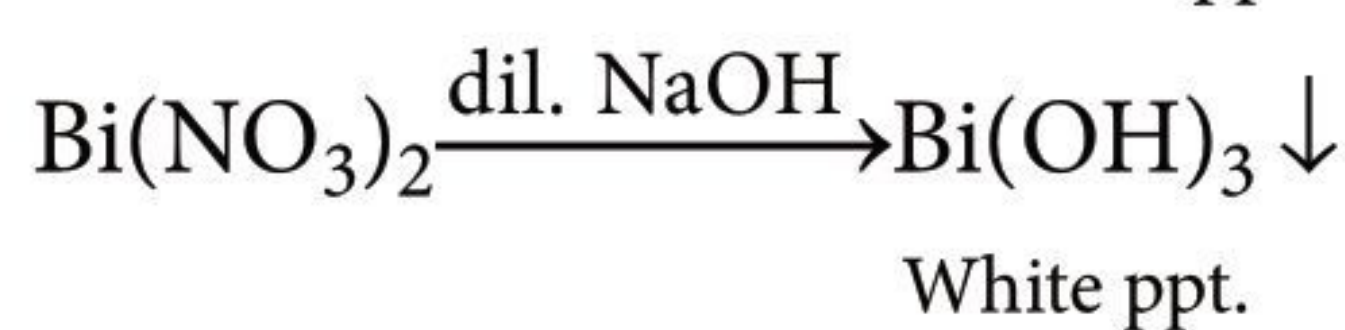
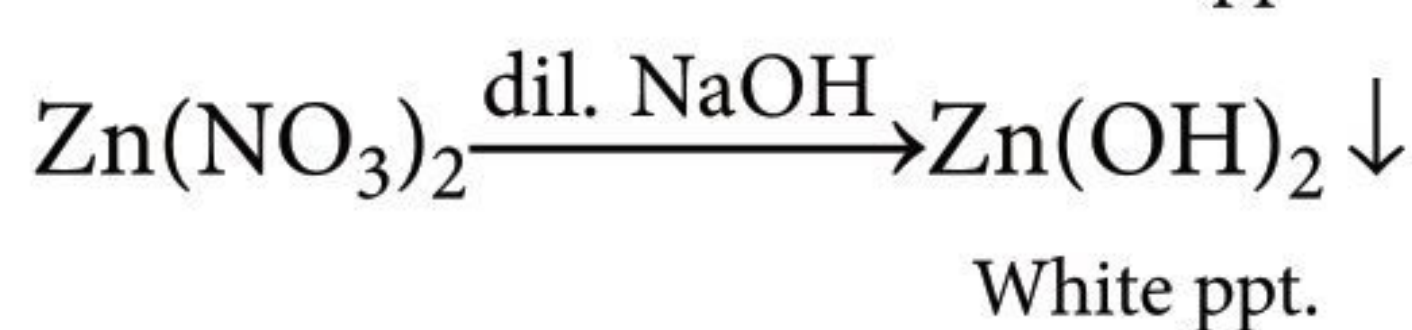
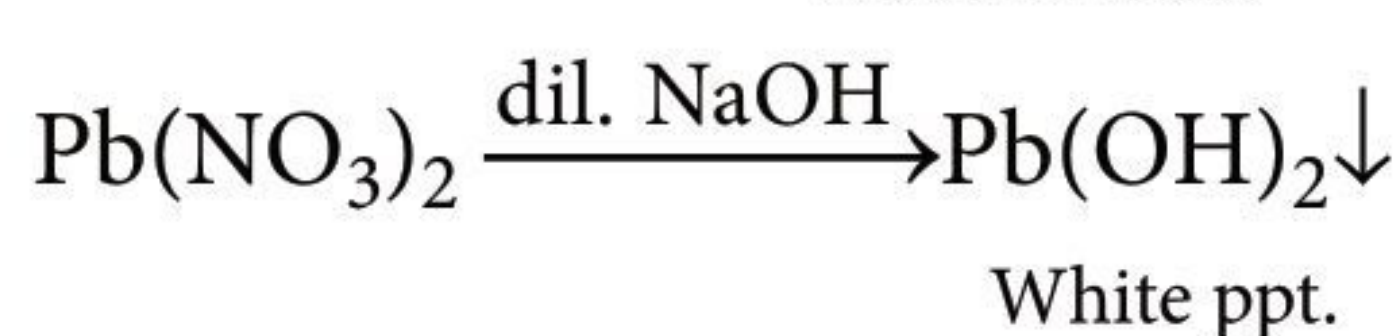
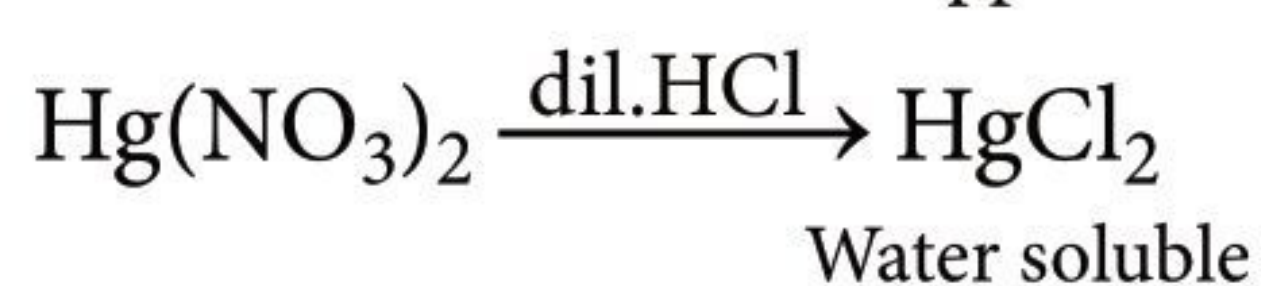
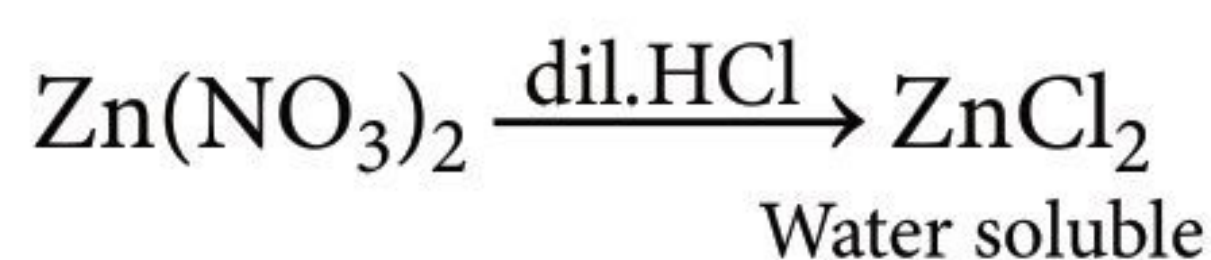
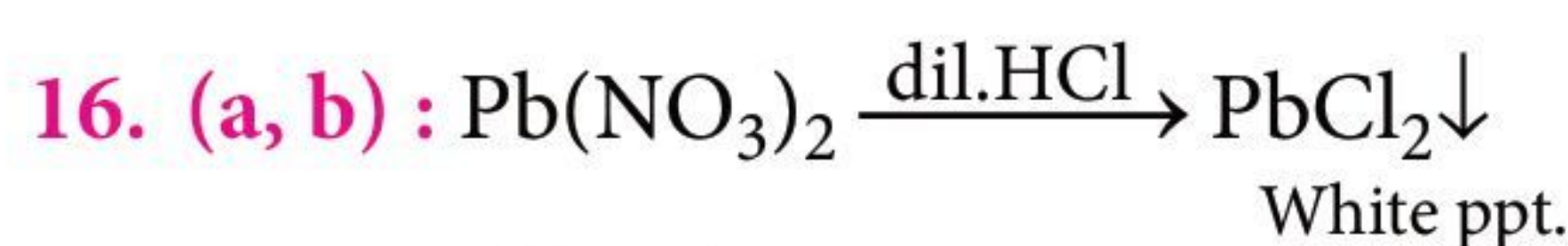
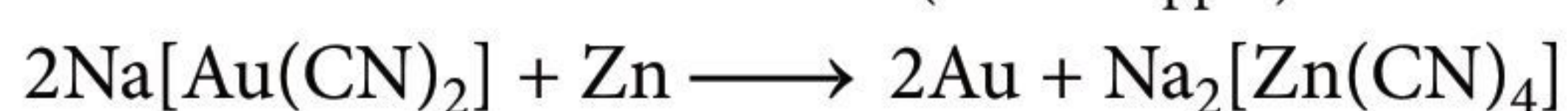
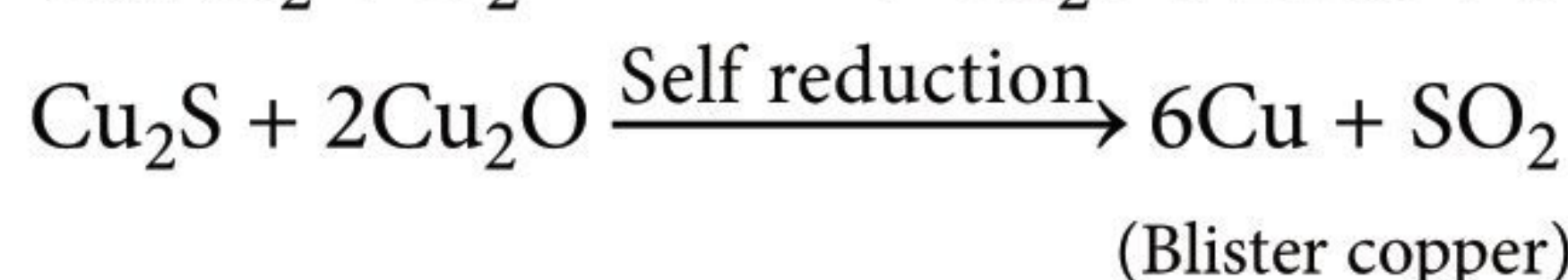
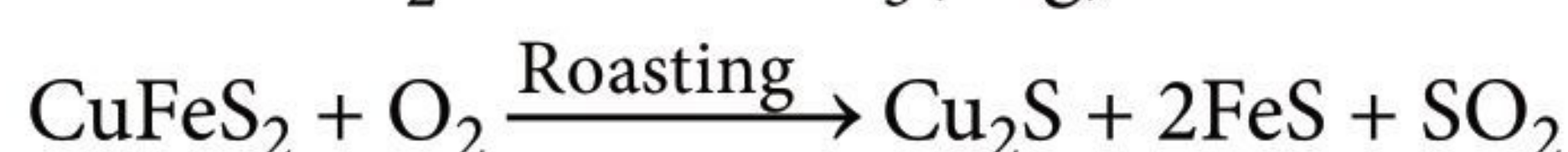
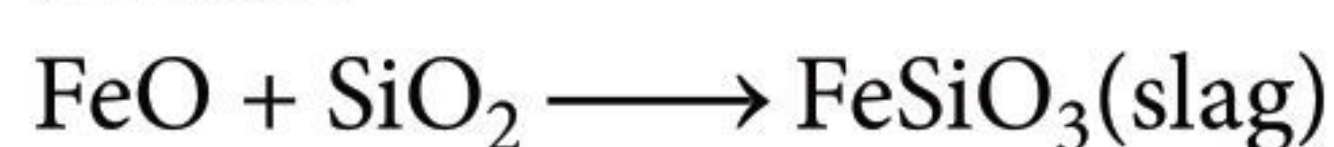
Adiabatic expansion : (II to III)

V increases, P decreases, T decreases, H decreases, S constant. So, a, b, d are correct.

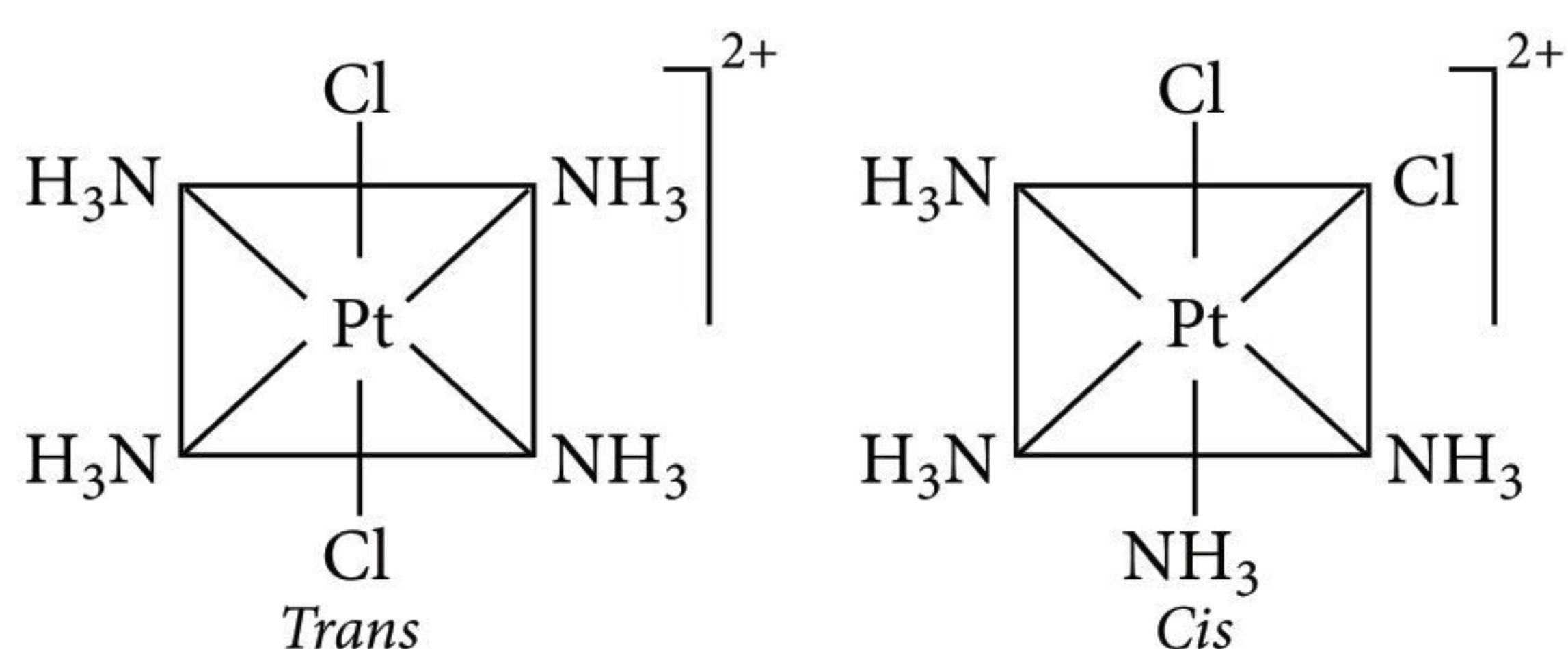
15. (a, c, d): $\text{PbS} + 2\text{PbO} \longrightarrow \text{SO}_2 + 3\text{Pb}$

Self-reduction

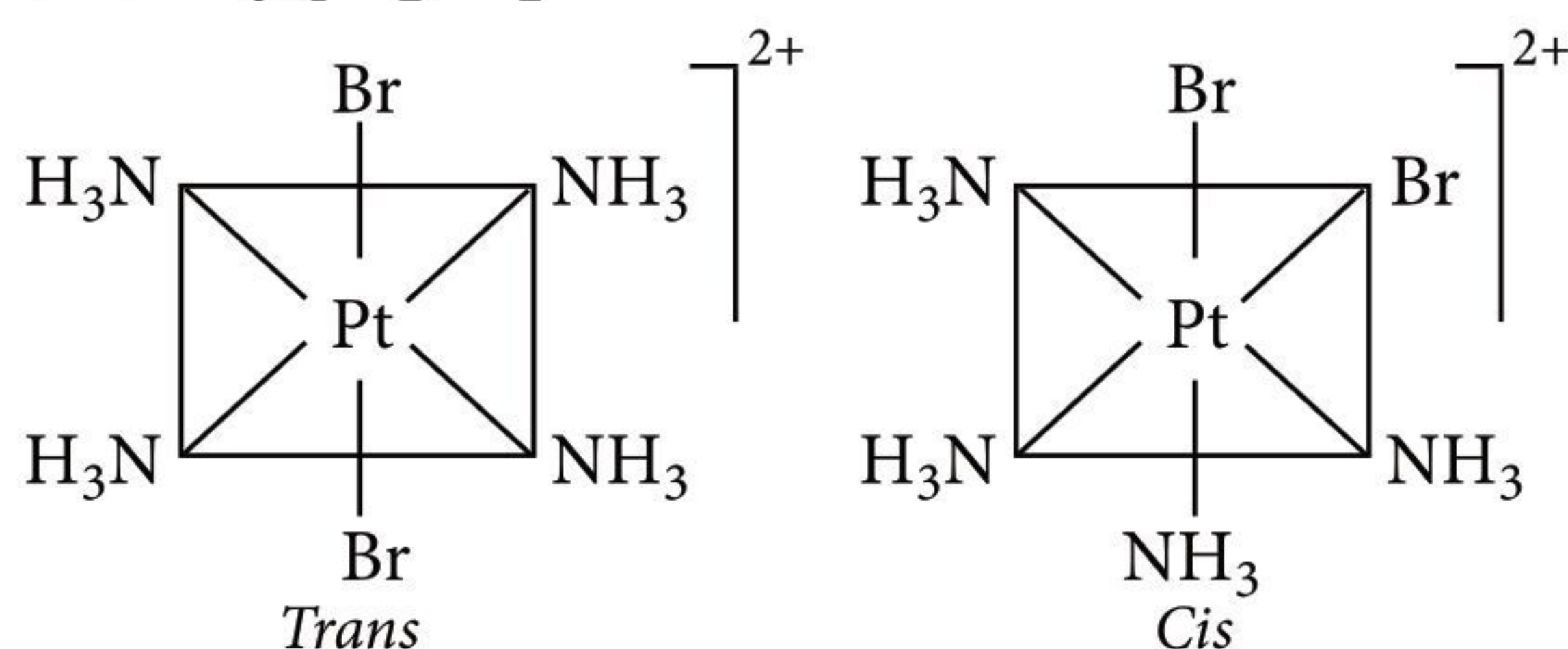
In extraction process of copper from copper pyrites, silica is added to remove Fe impurity produce ferrous silicate.



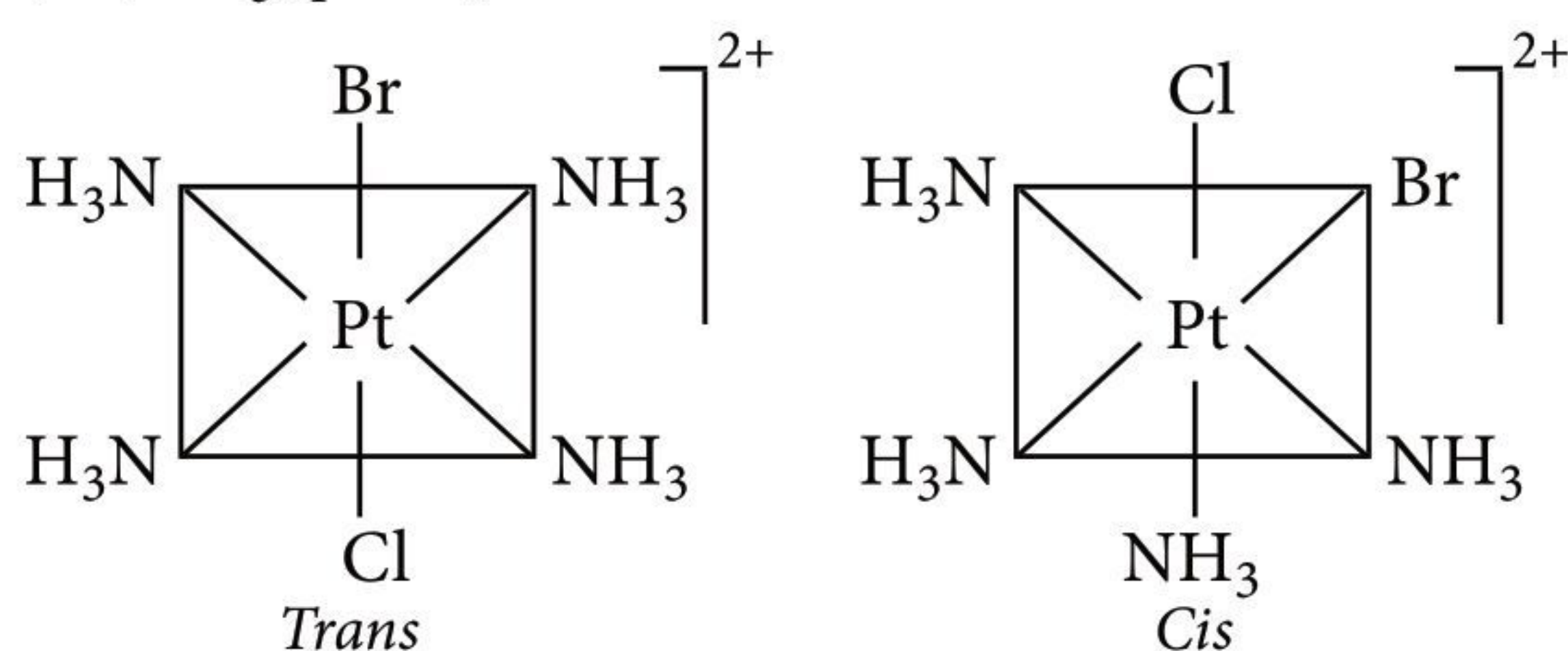
19. (6): $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]\text{Br}_2$

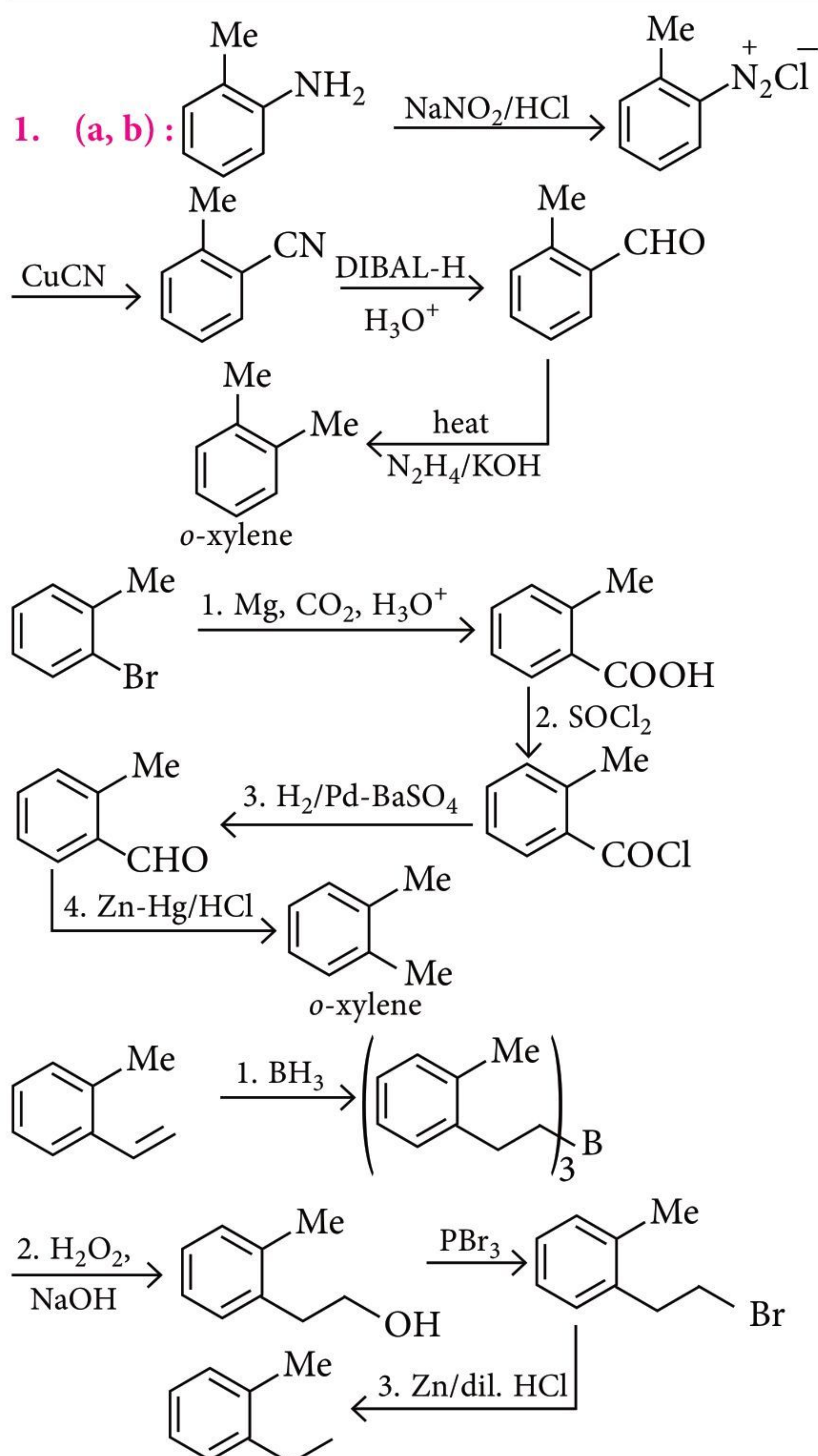


$[\text{Pt}(\text{NH}_3)_4\text{Br}_2]\text{Cl}_2$

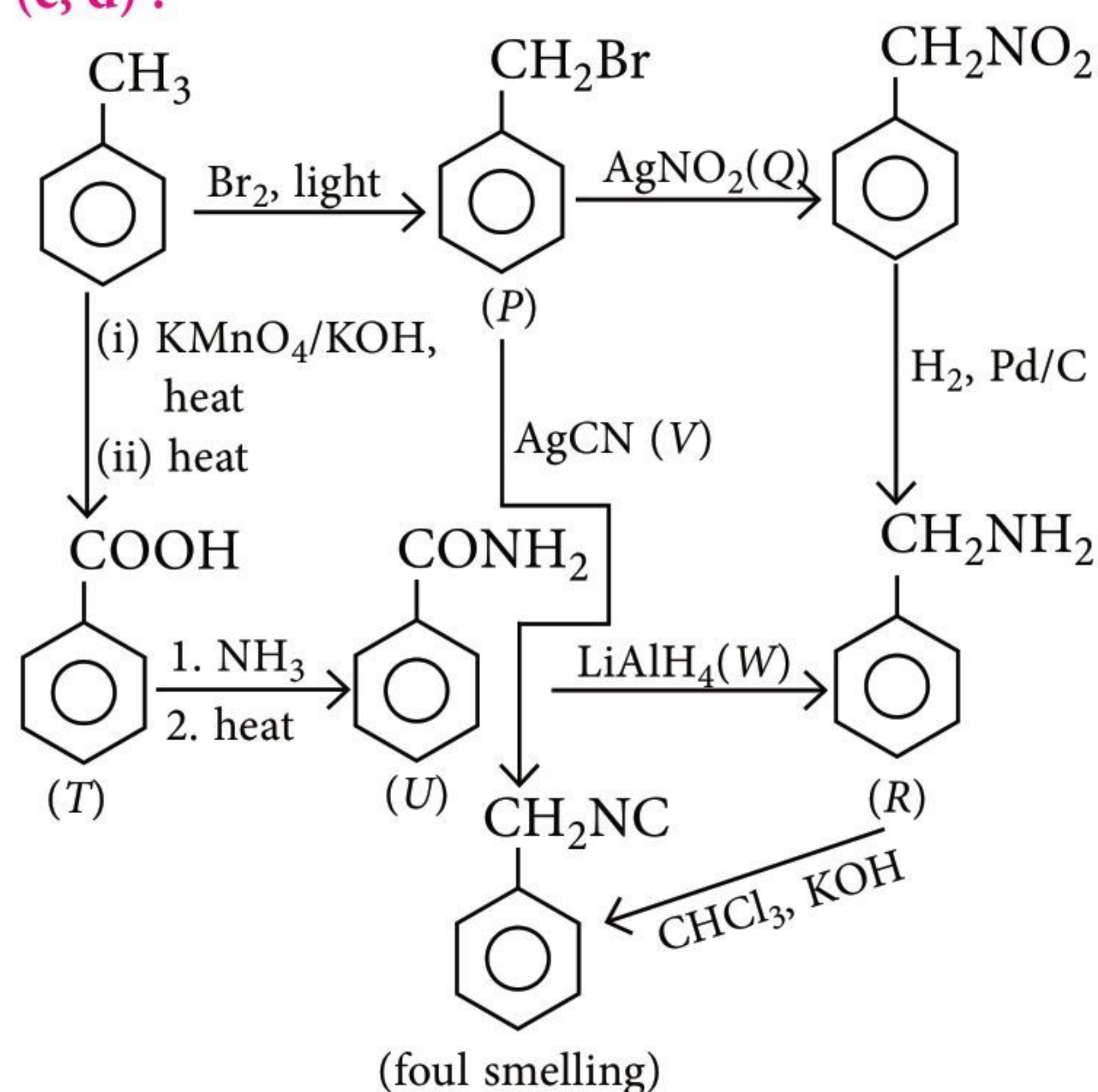


$[\text{Pt}(\text{NH}_3)_4\text{ClBr}]\text{ClBr}$

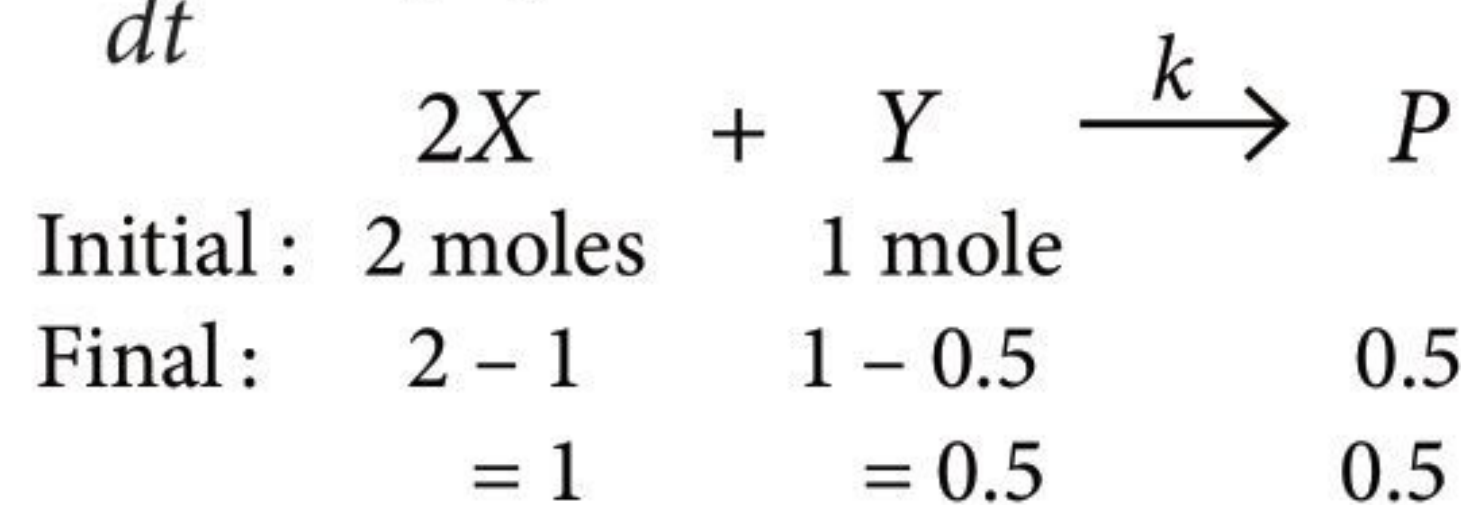




2. (c, d):



$$\frac{d[P]}{dt} = k[X]$$



$$-\frac{d[X]}{dt} = k_1[X] = 2k[X] \Rightarrow 2k = k_1$$

$$-\frac{d[Y]}{dt} = k_2[X] = k[X] \Rightarrow k_2 = k$$

$$2k = \frac{1}{50} \ln 2$$

$$k = \frac{1}{100} \ln 2 = \frac{0.693}{100} = 6.93 \times 10^{-3} \text{ s}^{-1}$$

$$t_{1/2} = \frac{\ln 2}{k_1} = \frac{\ln 2 \times 100}{2 \times 0.693} = 500 \text{ sec}$$

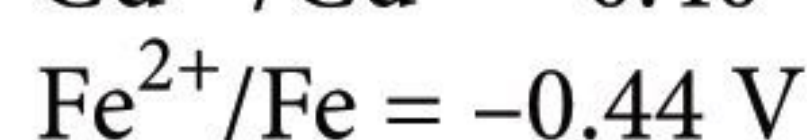
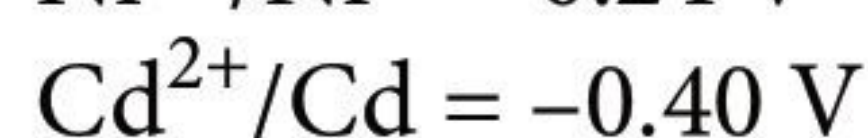
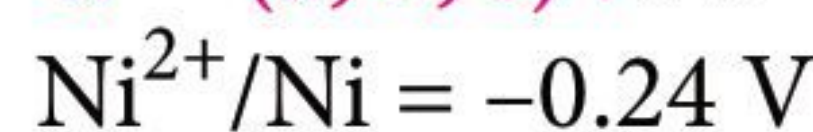
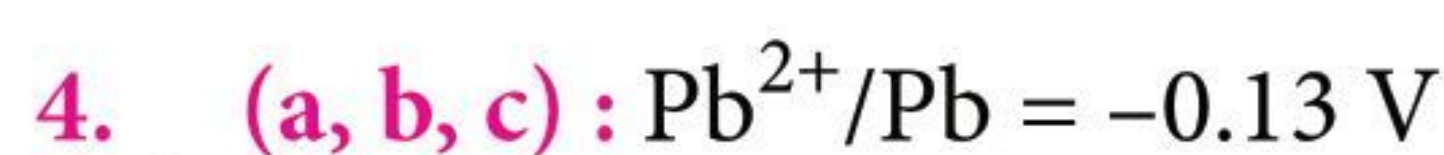
At 50 sec

$$-\frac{d[X]}{dt} = 2k[X] = 2 \times \frac{0.693}{100} \times 1 = 13.86 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$$

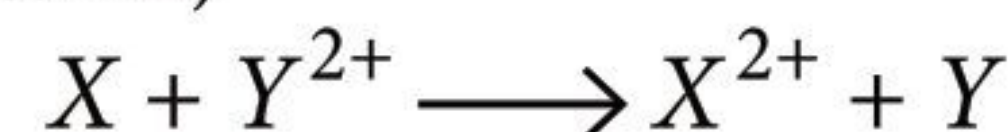
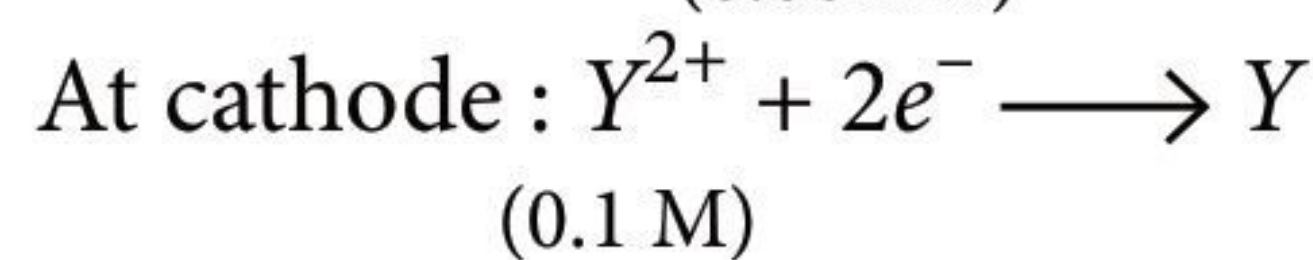
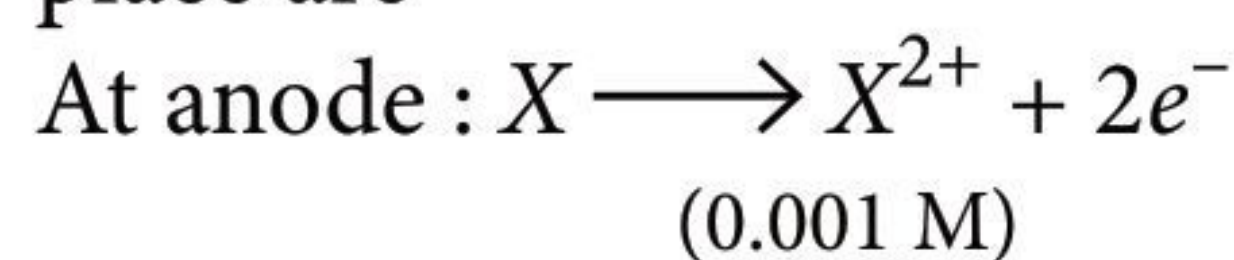
At 100 sec

$$-\frac{d[Y]}{dt} = k_2[X] = k[X] = \frac{0.693}{100} \times \frac{1}{2} = 3.46 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$$

[∵ concentration of X after 2 half life = $\frac{1}{2} M$]



As X is getting dissolved that means reactions taking place are



$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.059}{2} \log \frac{[X^{2+}]}{[Y^{2+}]}$$

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} + 0.06$$

For Cd/Ni cell, $E_{\text{cell}}^{\circ} = E_{\text{red}}^{\circ} - E_{\text{oxid}}^{\circ}$

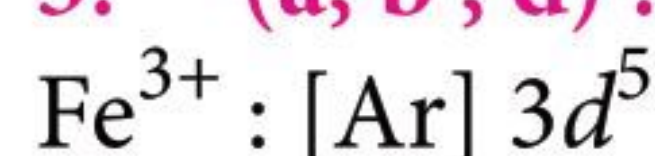
$$= -0.24 - (-0.40) = +0.16 \text{ V}$$

$$E_{\text{cell}} = 0.22 \text{ V}$$

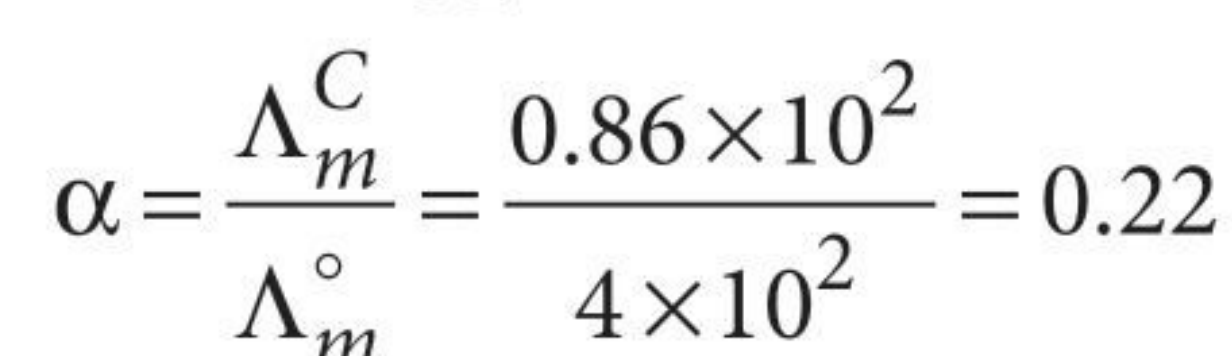
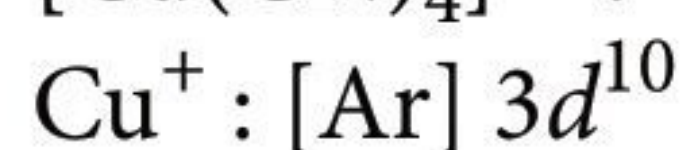
For Cd/Fe cell, $E_{\text{cell}}^{\circ} = -0.04$, $E_{\text{cell}} = 0.02$

For Ni/Pb cell, $E_{\text{cell}}^{\circ} = 0.11 \text{ V}$, $E_{\text{cell}} = 0.17 \text{ V}$

For Ni/Fe cell, $E_{\text{cell}}^{\circ} = -0.2 \text{ V}$, $E_{\text{cell}} = -0.14 \text{ V}$



Cl^- is a weak ligand so no pairing will take place, hybridisation: sp^3 ; geometry: tetrahedral



9. (3.57): $3\text{Sn} + 6\text{HCl} + \text{C}_6\text{H}_5\text{NO}_2 \rightarrow \text{C}_6\text{H}_5\text{NH}_2 + 3\text{SnCl}_2 + 2\text{H}_2\text{O}$

3 mol 1 mol 1 mol

$\downarrow \text{HCl}$

$\text{C}_6\text{H}_5\text{NH}_3^+\text{Cl}^-$

1 mol

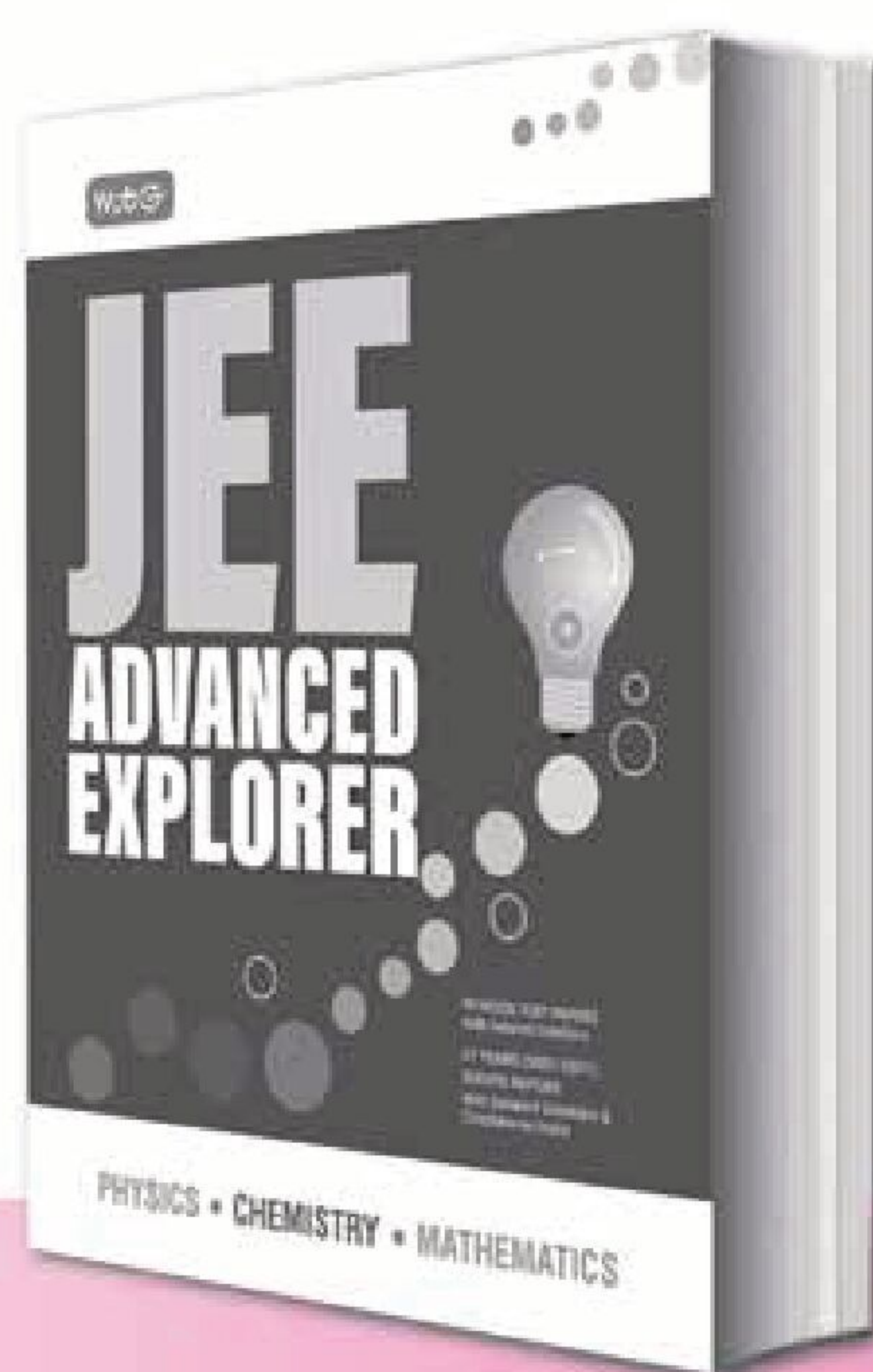
$$\begin{array}{ccccccc}
 \begin{array}{c} \bullet \\ | \\ \text{CH}_2 \\ | \\ \text{C}_6\text{H}_5 \end{array} & > & (\text{CH}_3)_2\text{C}\bullet & > & \text{CH}_2=\text{C}\bullet & > & \text{CH}\equiv\text{C}\bullet \\
 \text{(Resonance)} & & (sp^3\text{-carbon}) & & (sp^2\text{-carbon}) & & (sp\text{-carbon}) \\
 \text{(Q)} & & (P) & & (R) & & \text{more electro} \\
 & & & & & & \text{negative)} \\
 & & & & & & (S)
 \end{array}$$

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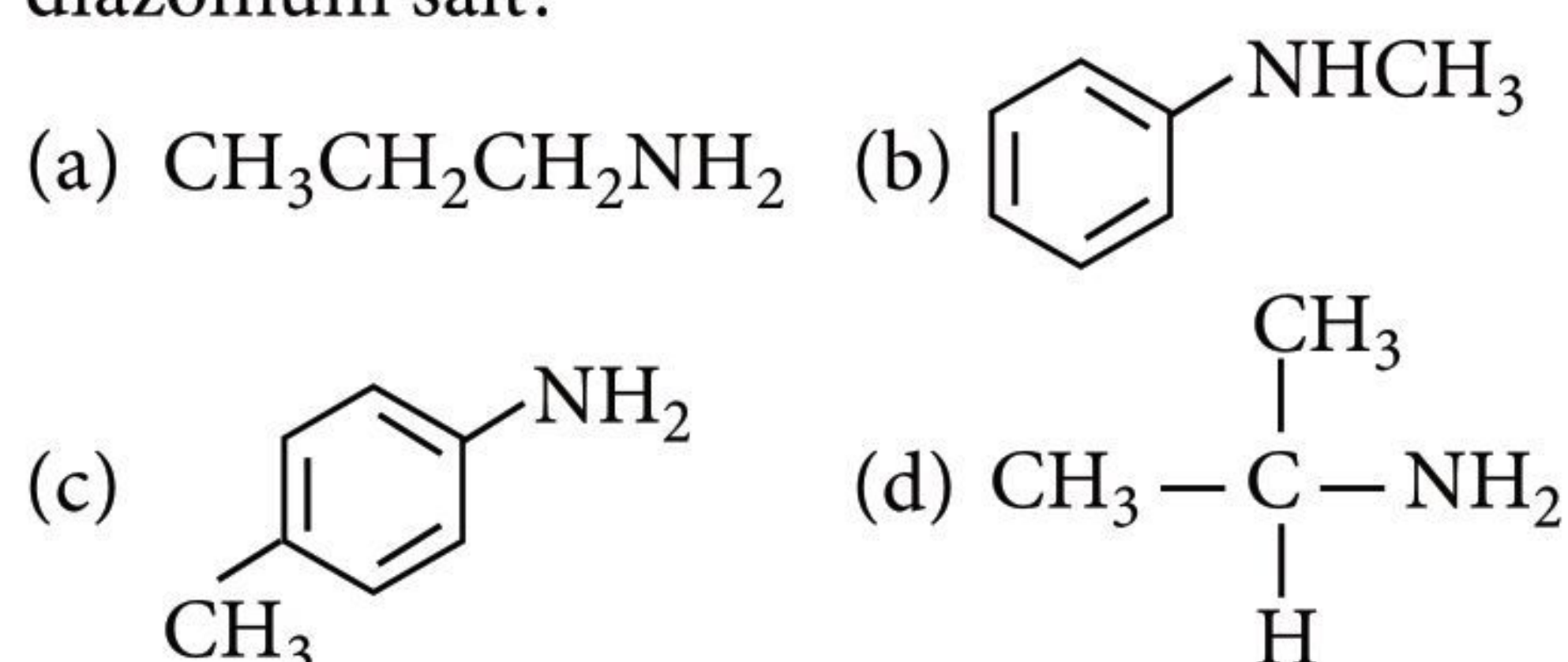
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SECTION - A (MULTIPLE CHOICE QUESTIONS)

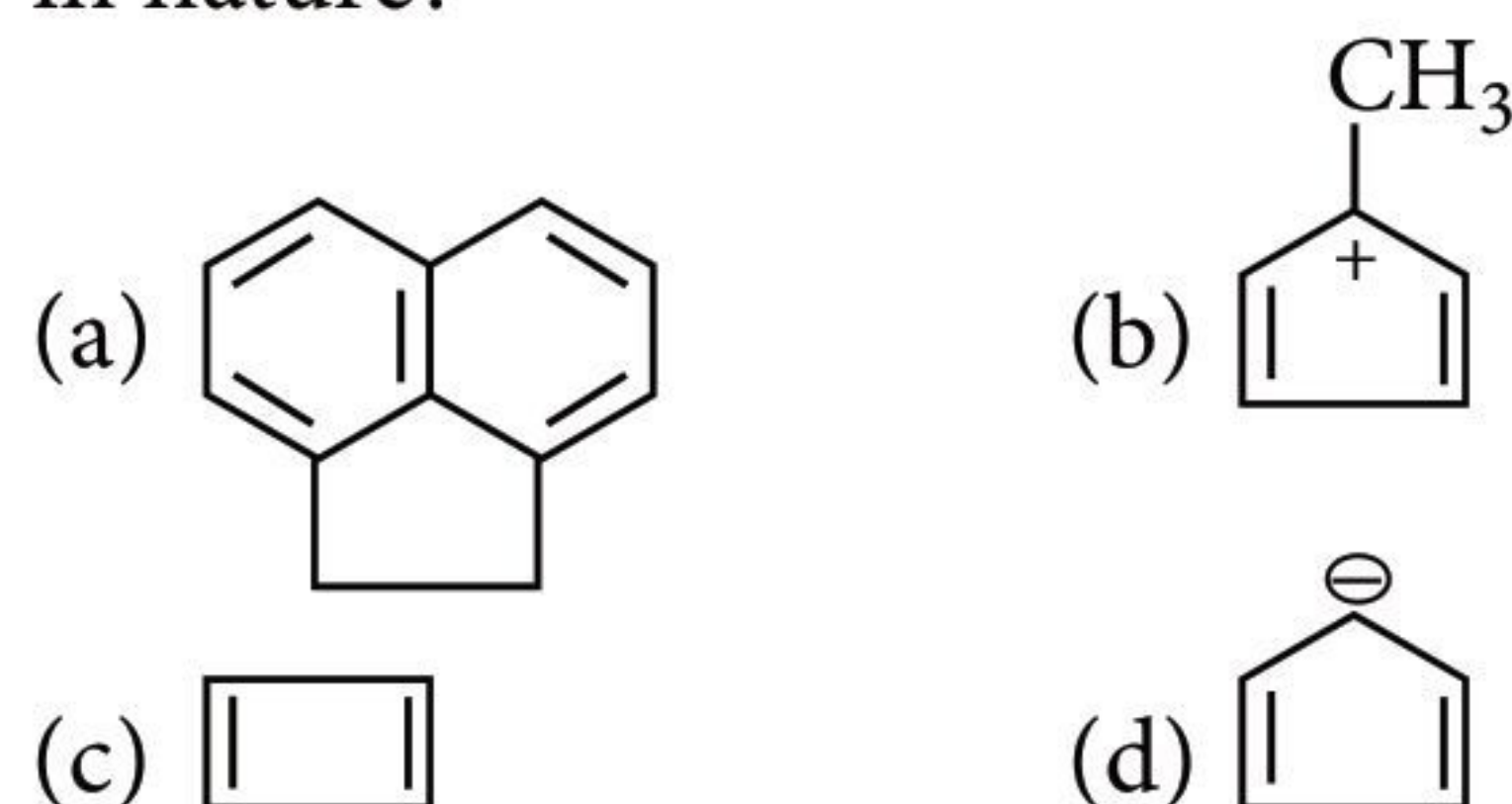
1. Which one of the following gives the most stable diazonium salt?



2. The potassium ferrocyanide solution gives a prussian blue colour, when added to

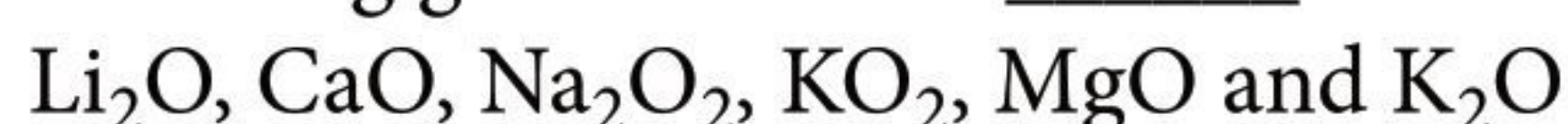


3. Which one of the following compounds is aromatic in nature?



4. Monomer units of dacron polymer are
(a) glycerol and phthalic acid
(b) ethylene glycol and phthalic acid
(c) ethylene glycol and terephthalic acid
(d) glycerol and terephthalic acid.

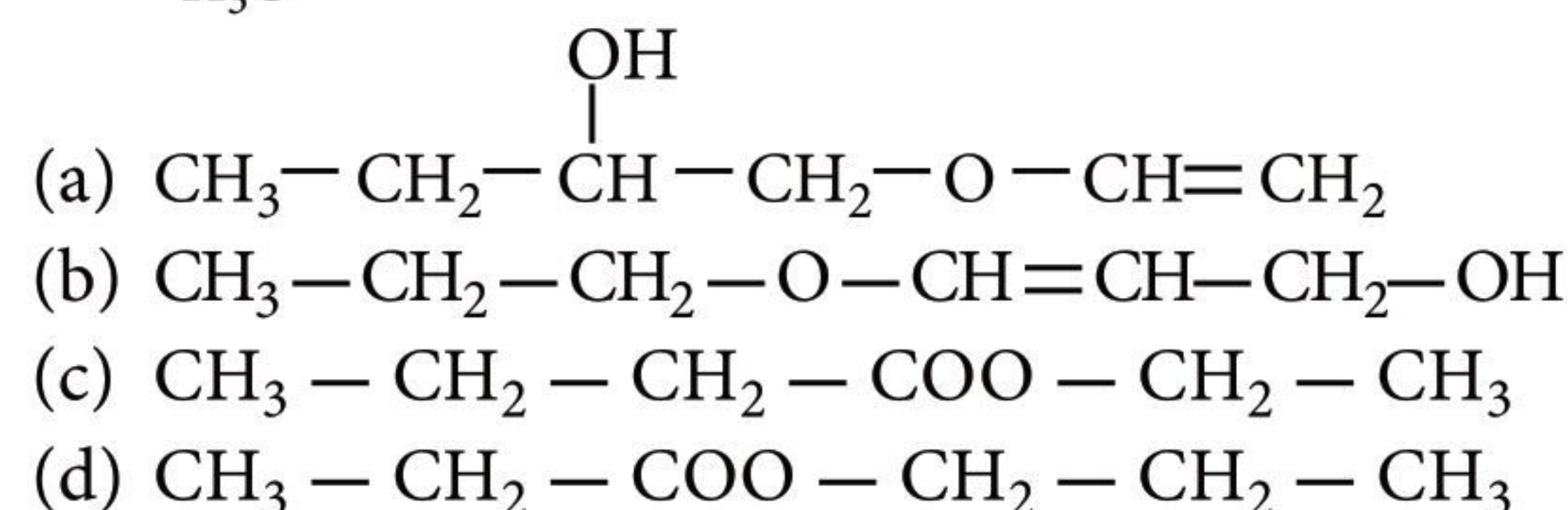
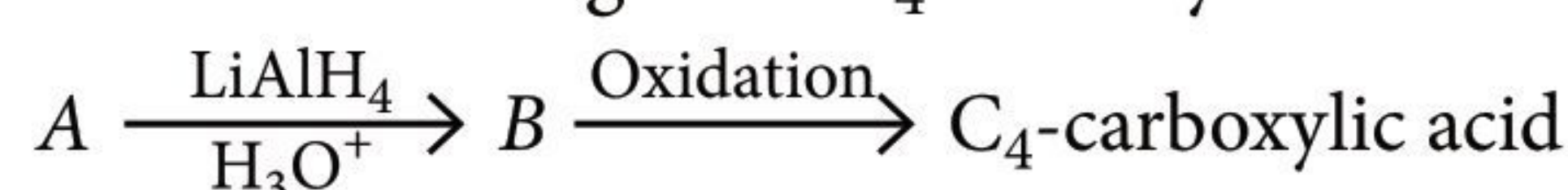
5. Number of paramagnetic oxides among the following given oxides is ____.



6. Experimentally reducing a functional group cannot be done by which one of the following reagents?



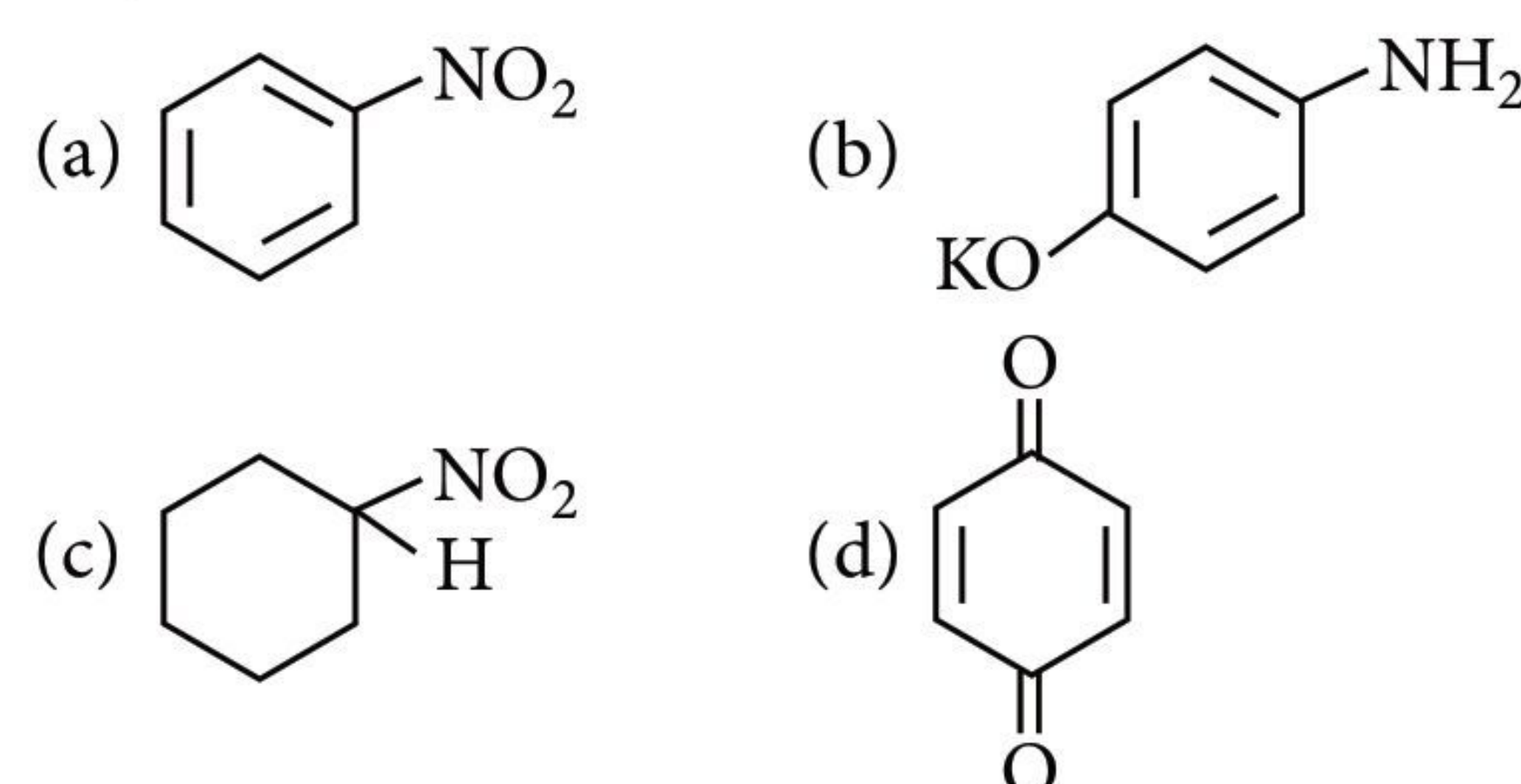
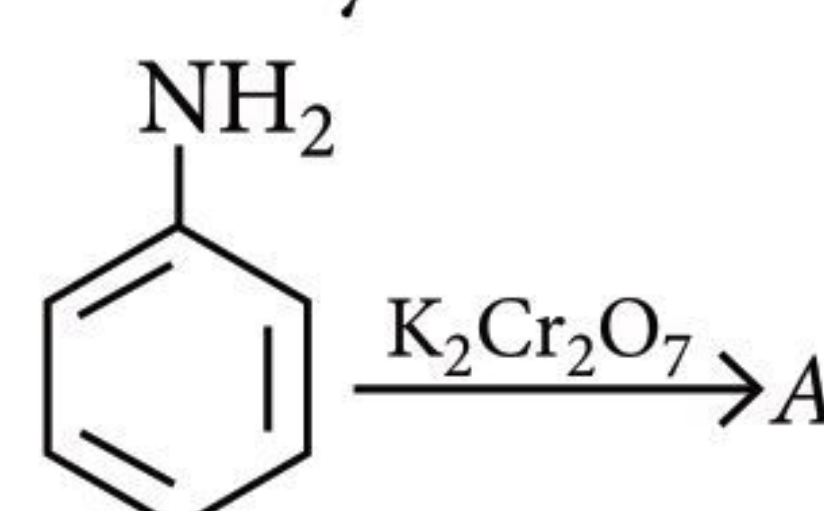
7. In the following sequence of reactions a compound A, (molecular formula $\text{C}_6\text{H}_{12}\text{O}_2$) with a straight chain structure gives a C_4 carboxylic acid. A is



8. Water sample is called cleanest on the basis of which one of the BOD values given below?



9. Identify A in the following reaction.



10. Given below are two statements :

Statement I : The nucleophilic addition of sodium hydrogen sulphite to an aldehyde or a ketone involves proton transfer to form a stable ion.

Statement II : The nucleophilic addition of hydrogen cyanide to an aldehyde or a ketone yields amine as final product.

In the light of the above statements, choose the most appropriate answer from the options given below.

- (a) Both statement I and statement II are false.
- (b) Both statement I and statement II are true.
- (c) Statement I is false but statement II is true.
- (d) Statement I is true but statement II is false.

11. Match List-I with List-II.

List-I (Colloid Preparation Method)	List-II (Chemical Reaction)
--	--------------------------------

(A) Hydrolysis	(i) $2\text{AuCl}_3 + 3\text{HCHO} + 3\text{H}_2\text{O} \rightarrow 2\text{Au(sol)} + 3\text{HCOOH} + 6\text{HCl}$
(B) Reduction	(ii) $\text{As}_2\text{O}_3 + 3\text{H}_2\text{S} \rightarrow \text{As}_2\text{S}_3(\text{sol}) + 3\text{H}_2\text{O}$
(C) Oxidation	(iii) $\text{SO}_2 + 2\text{H}_2\text{S} \rightarrow 3\text{S(sol)} + 2\text{H}_2\text{O}$
(D) Double decomposition	(iv) $\text{FeCl}_3 + 3\text{H}_2\text{O} \rightarrow \text{Fe(OH)}_3(\text{sol}) + 3\text{HCl}$

Choose the most appropriate answer from the options given below.

- (a) (A) – (i), (B) – (iii), (C) – (ii), (D) – (iv)
- (b) (A) – (iv), (B) – (i), (C) – (iii), (D) – (ii)
- (c) (A) – (i), (B) – (ii), (C) – (iv), (D) – (iii)
- (d) (A) – (iv), (B) – (ii), (C) – (iii), (D) – (i)

12. The stereoisomers that are formed by electrophilic addition of bromine to *trans*-but-2-ene is/are

- (a) 2 identical mesomers
- (b) 2 enantiomers
- (c) 2 enantiomers and 2 mesomers
- (d) 1 racemic and 2 enantiomers.

13. The oxide without nitrogen–nitrogen bond is

- (a) N_2O_4
- (b) N_2O
- (c) N_2O_5
- (d) N_2O_3

14. Calamine and malachite, respectively, are the ores of

- (a) copper and iron
- (b) zinc and copper
- (c) aluminium and zinc
- (d) nickel and aluminium.

15. In the given chemical reaction, colours of the Fe^{2+} and Fe^{3+} ions, are respectively

- $5\text{Fe}^{2+} + \text{MnO}_4^- + 8\text{H}^+ \longrightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O} + 5\text{Fe}^{3+}$
- (a) Yellow, Green
 - (b) Yellow, Orange
 - (c) Green, Orange
 - (d) Green, Yellow

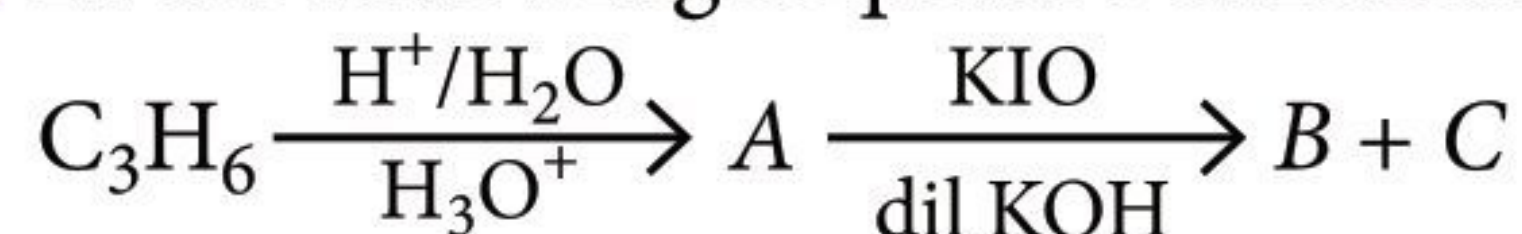
16. Identify the element for which electronic configuration in +3 oxidation state is $[\text{Ar}]3d^5$.

- (a) Ru
- (b) Mn
- (c) Co
- (d) Fe

17. The Crystal Field Stabilization Energy (CFSE) and magnetic moment (spin-only) of an octahedral aqua complex of a metal ion (M^{Z+}) are $-0.8 \Delta_0$ and 3.87 BM, respectively. Identify (M^{Z+}).

- (a) V^{3+}
- (b) Co^{2+}
- (c) Cr^{3+}
- (d) Mn^{4+}

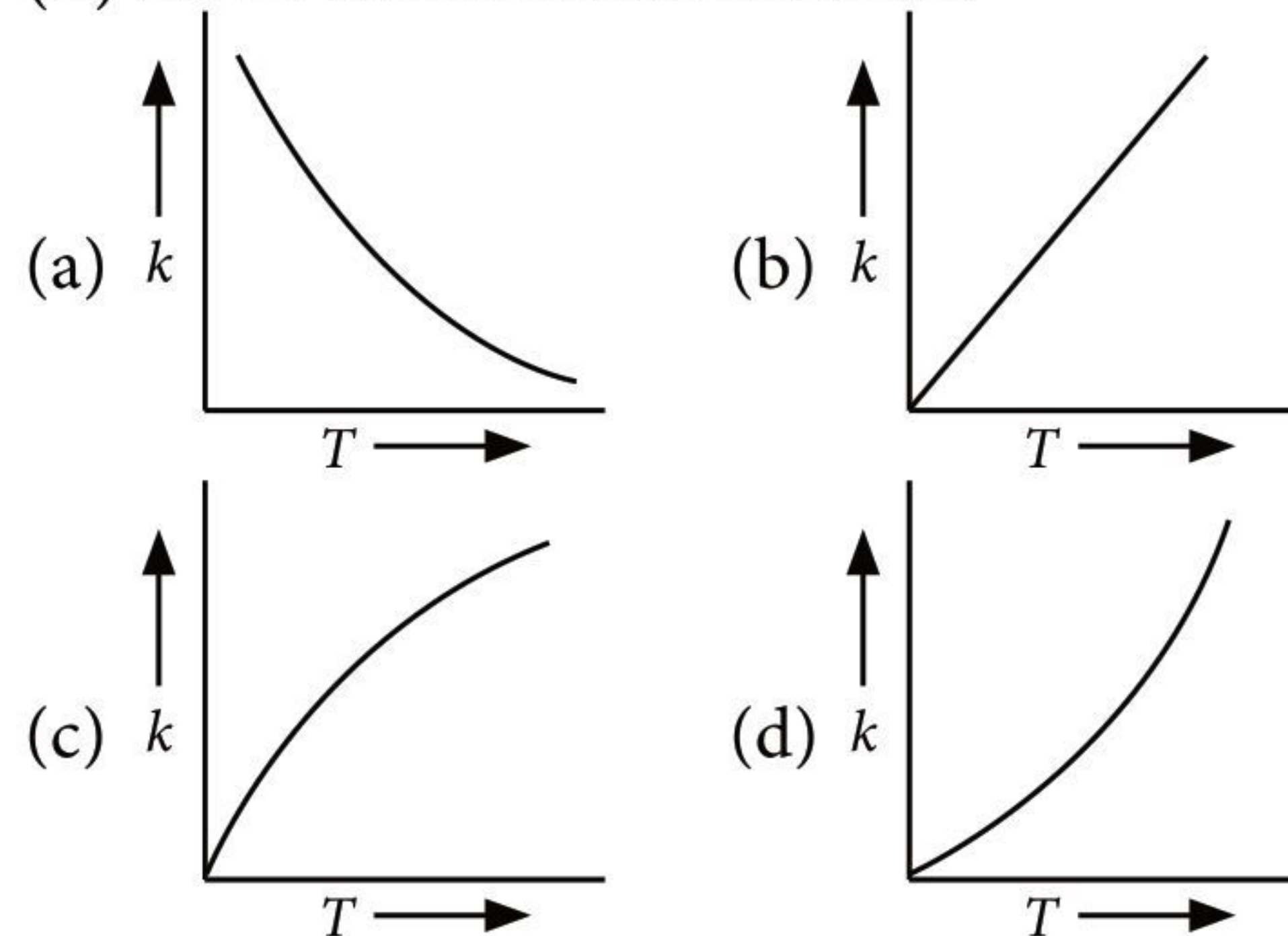
18. In the following sequence of reactions,



The compounds B and C respectively are

- (a) Cl_3COOK , CH_3I
- (b) CH_3I , HCOOK
- (c) Cl_3COOK , HCOOH
- (d) CHI_3 , CH_3COOK

19. Which one of the following given graphs represents the variation of rate constant (k) with temperature (T) for an endothermic reaction?



20. Hydrogen peroxide reacts with iodine in basic medium to give

- (a) IO^-
- (b) IO_3^-
- (c) I^-
- (d) IO_4^-

SECTION - B (NUMERICAL VALUE TYPE)

Attempt any 5 questions out of 10.

21. If the conductivity of mercury at 0°C is $1.07 \times 10^6 \text{ S m}^{-1}$ and the resistance of a cell containing mercury is 0.243Ω , then the cell constant of the cell is $x \times 10^4 \text{ m}^{-1}$. The value of x is _____. (Nearest integer)

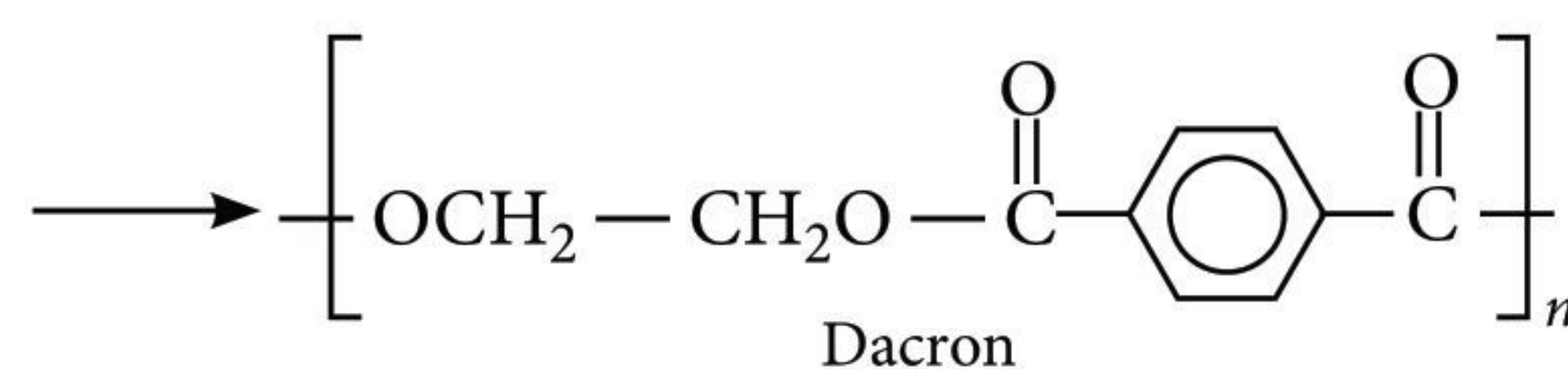
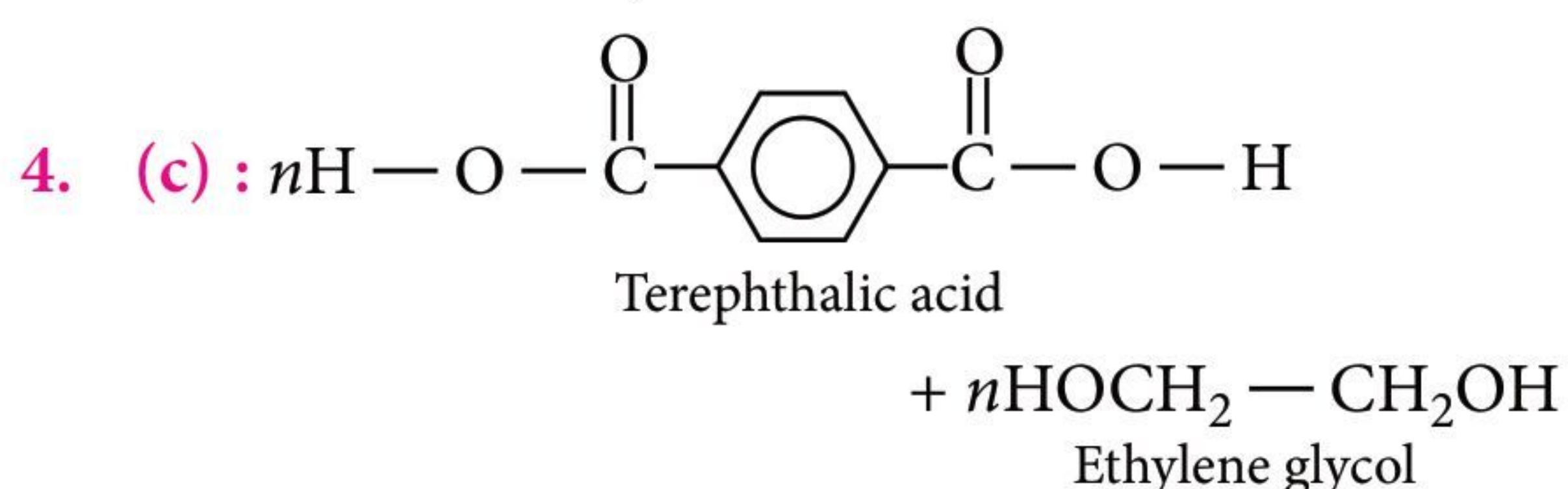
22. A 50 watt bulb emits monochromatic red light of wavelength of 795 nm. The number of photons emitted per second by the bulb is $x \times 10^{20}$. The value of x is _____. (Nearest integer)
[Given : $h = 6.63 \times 10^{-34} \text{ J s}$ and $c = 3.0 \times 10^8 \text{ m s}^{-1}$]

23. If 80 g of copper sulphate $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is dissolved in deionised water to make 5 L solution, the concentration of the copper sulphate solution is $x \times 10^{-3} \text{ mol L}^{-1}$. The value of x is _____. [Atomic masses : Cu : 63.54 u, S : 32 u, O : 16 u, H : 1 u]

24. The sum of oxidation states of two silver ions in $[\text{Ag}(\text{NH}_3)_2][\text{Ag}(\text{CN})_2]$ complex is _____.
25. For the reaction : $2\text{NO}_{2(g)} \rightarrow \text{N}_2\text{O}_{4(g)}$, when $\Delta S = 176.0 \text{ J K}^{-1}$ and $\Delta H = -57.8 \text{ kJ mol}^{-1}$, the magnitude of ΔG at 298 K for the reaction is _____ kJ mol^{-1} . (Nearest integer)
26. A peptide synthesised by the reactions of one molecule each of glycine, leucine, aspartic acid and histidine will have _____ peptide linkages.
27. The spin-only magnetic moment value of B_2^+ species is _____ $\times 10^{-2}$ BM. (Nearest integer) [Given : $\sqrt{3} = 1.73$]
28. The number of atoms in 8 g of sodium is $x \times 10^{23}$. The value of x is _____. (Nearest integer) [Given : $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$, atomic mass of Na = 23.0 u]
29. An empty LPG cylinder weighs 14.8 kg. When full, it weighs 29.0 kg and shows a pressure of 3.47 atm. In the course of use at ambient temperature, the mass of the cylinder is reduced to 23.0 kg. The final pressure inside the cylinder is _____ atm. (Nearest integer) (Assume LPG to be an ideal gas)
30. The molar solubility of $\text{Zn}(\text{OH})_2$ in 0.1 M NaOH solution is $x \times 10^{-18}$ M. The value of x is _____. (Nearest integer) (Given : The solubility product of $\text{Zn}(\text{OH})_2$ is 2×10^{-20})

SOLUTIONS

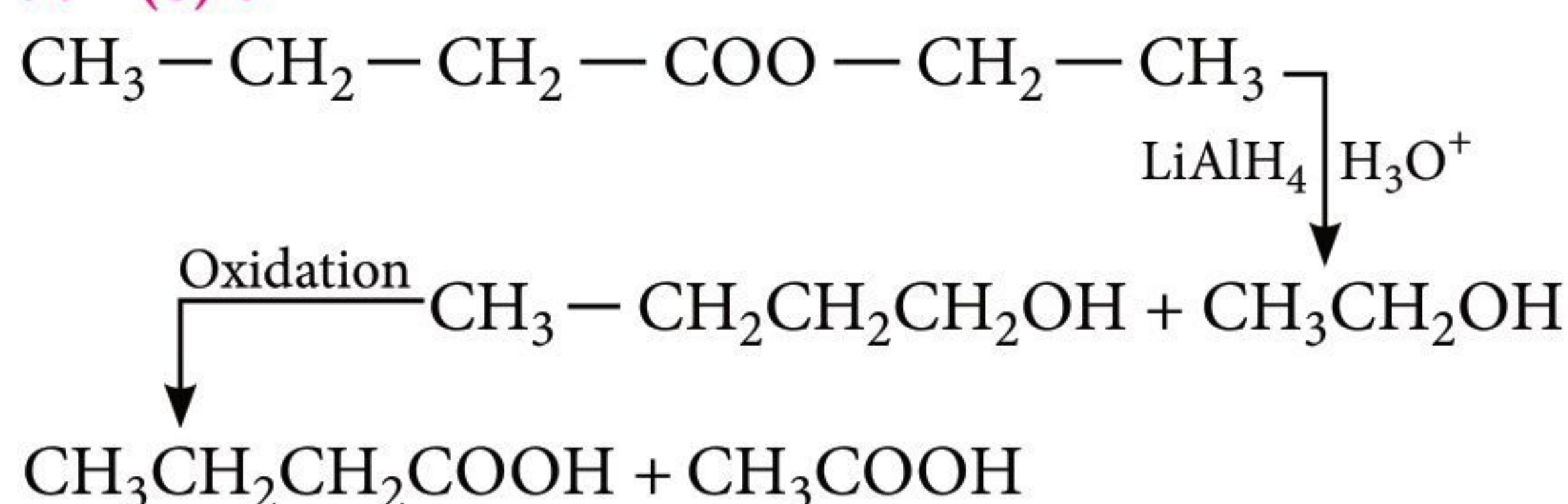
1. (c) : Aromatic diazonium salts are more stable than aliphatic diazonium salts due to dispersion of positive charge over the benzene ring caused by resonance.
2. (d) : If the solution containing ferric chloride is treated with potassium ferrocyanide solution, a blue ppt. is obtained.
 $4\text{FeCl}_3 + 3\text{K}_4[\text{Fe}(\text{CN})_6] \rightarrow \text{Fe}_4[\text{Fe}(\text{CN})_6]_3 + 12\text{KCl}$
3. (d) : Cyclopentadienyl anion is planar and has $(4n + 2)\pi$ electrons. Hence, it is aromatic in nature.



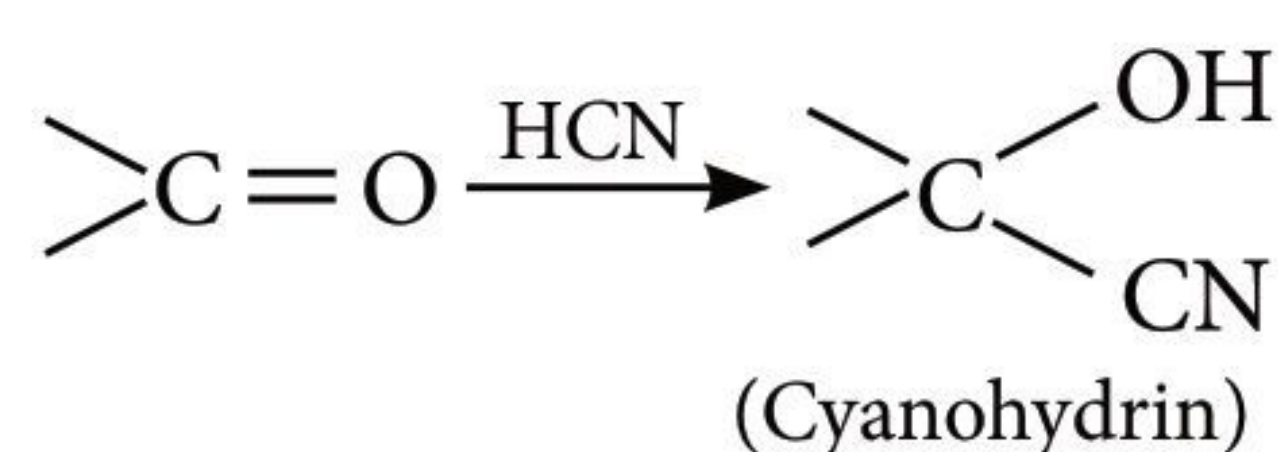
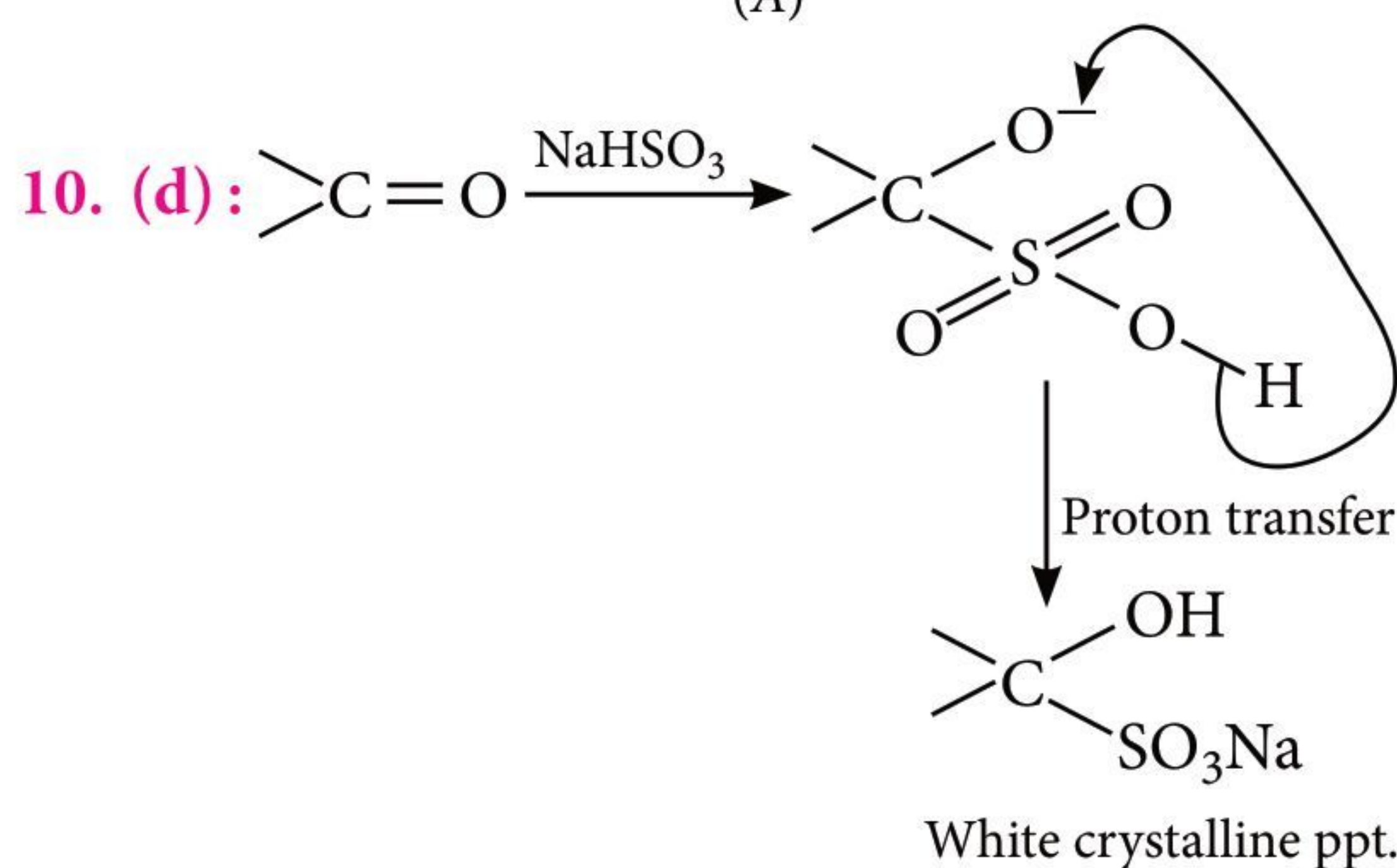
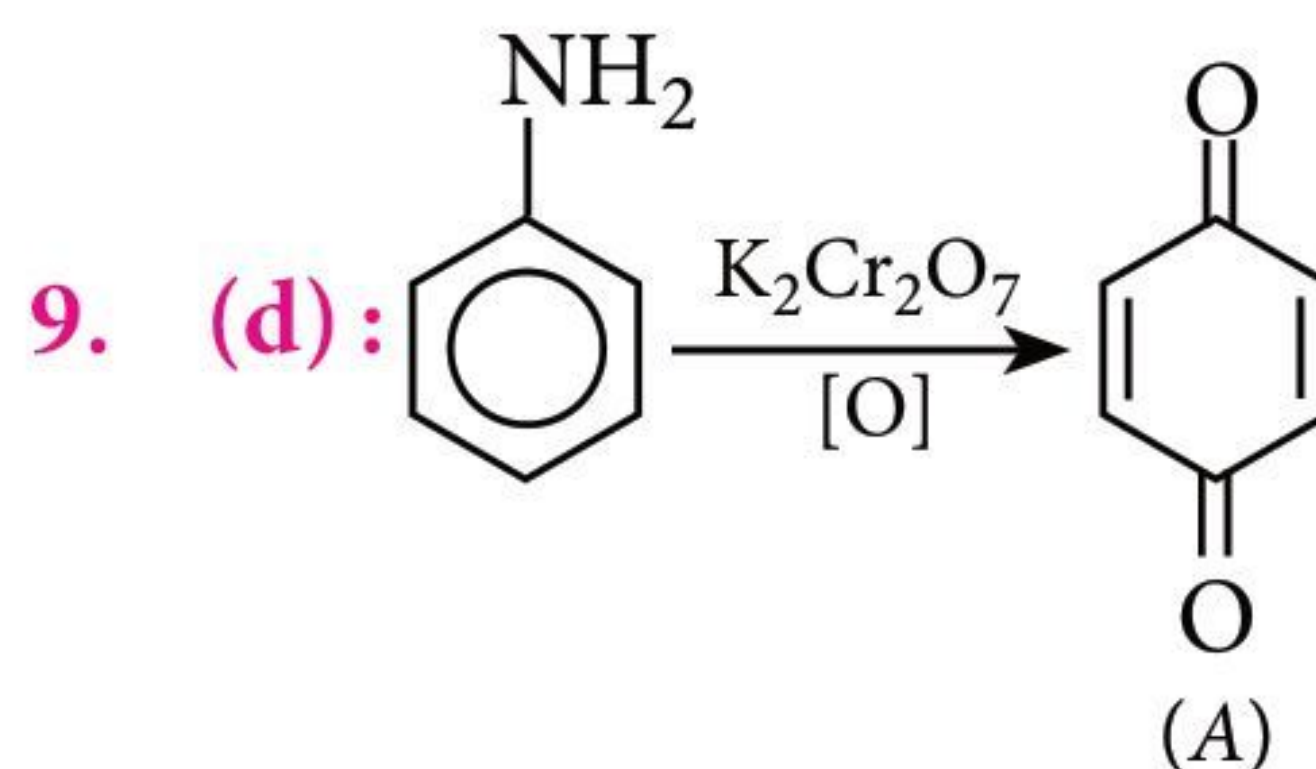
5. (a) : $\text{Li}_2\text{O} \Rightarrow \text{O}^{2-} \Rightarrow$ Diamagnetic
 $\text{CaO} \Rightarrow \text{O}^{2-} \Rightarrow$ Diamagnetic
 $\text{Na}_2\text{O}_2 \Rightarrow \text{O}_2^{2-} \Rightarrow$ Diamagnetic
 $\text{KO}_2 \Rightarrow \text{O}_2^- \Rightarrow$ Paramagnetic
 $\text{MgO} \Rightarrow \text{O}^{2-} \Rightarrow$ Diamagnetic
 $\text{K}_2\text{O} \Rightarrow \text{O}^{2-} \Rightarrow$ Diamagnetic

6. (d)

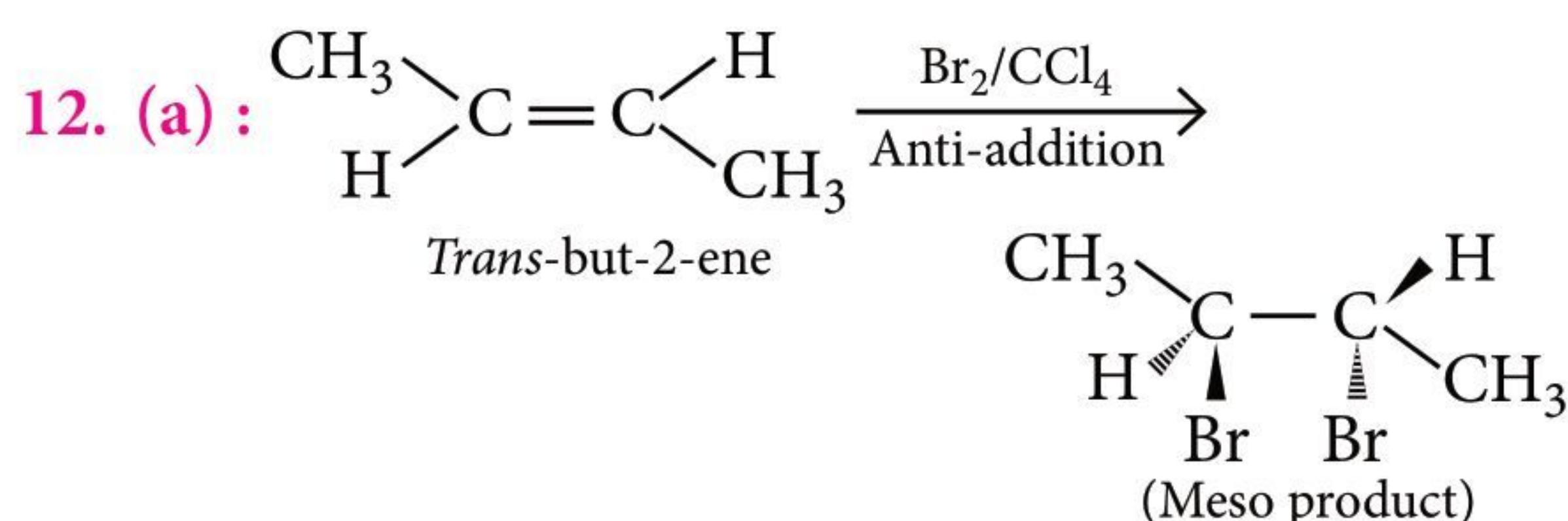
7. (c) :



8. (c) : Clean water has BOD value lesser than 5 ppm.



11. (b) : (A)-(iv), (B)-(i), (C)-(iii), (D)-(ii)



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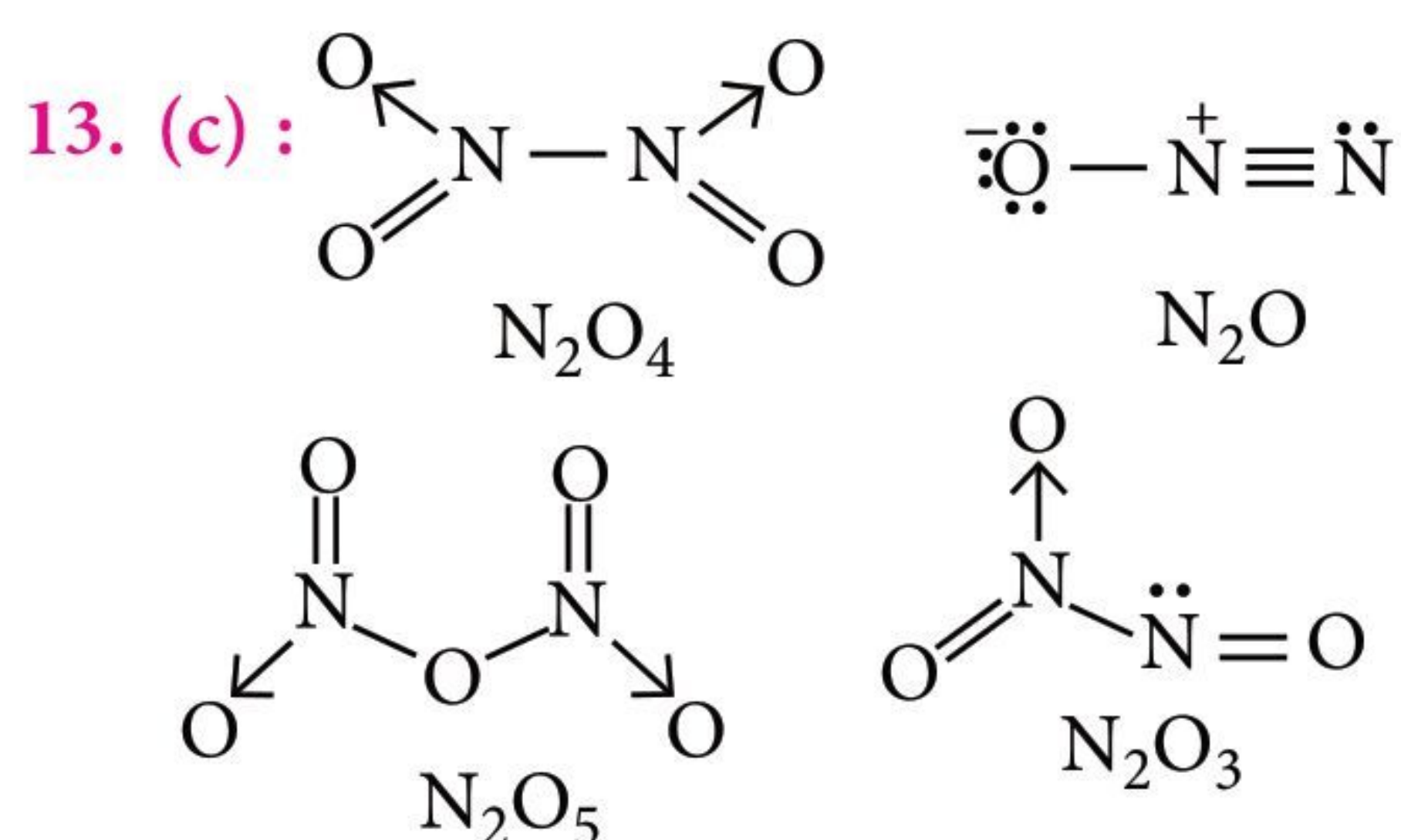
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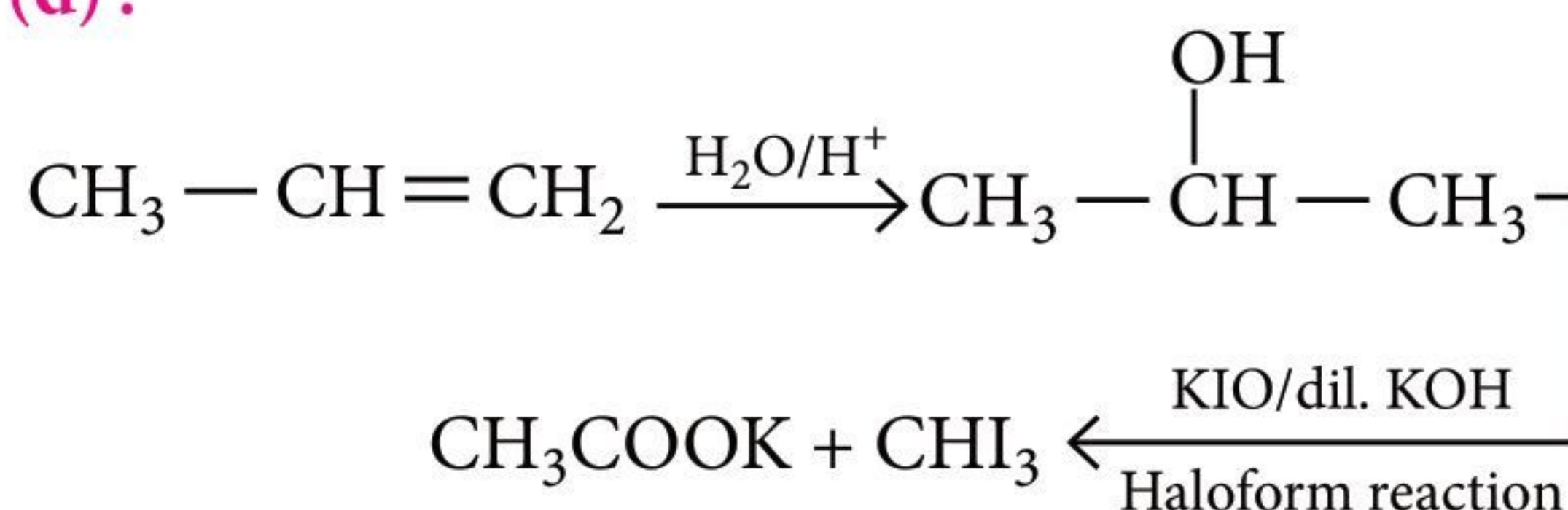
14. (b) : Calamine : $ZnCO_3$
 Malachite : $CuCO_3 \cdot Cu(OH)_2$

15. (d) : $Fe^{2+} \rightarrow$ green colour
 $Fe^{3+} \rightarrow$ yellow colour

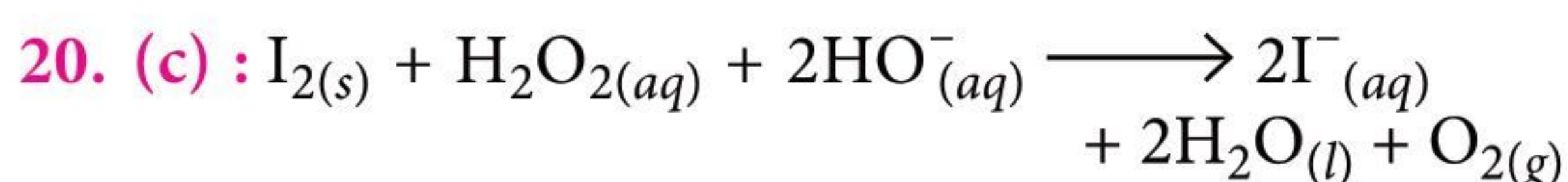
16. (d) :	E.C.	+3 Oxidation state
Ru(44)	$[Kr] 4d^7 5s^1$	$[Kr] 4d^5$
Mn(25)	$[Ar] 4s^2 3d^5$	$[Ar] 3d^4$
Co(27)	$[Ar] 4s^2 3d^7$	$[Ar] 3d^6$
Fe(26)	$[Ar] 4s^2 3d^6$	$[Ar] 3d^5$

17. (b) : Ion	E.C.	n	$\mu(BM)$	Δ_0
V^{3+}	$t_{2g}^2 e_g^0$	2	2.82	$-0.8\Delta_0$
Co^{2+}	$t_{2g}^5 e_g^2$	3	3.87	$-0.8\Delta_0$
Cr^{3+}	$t_{2g}^3 e_g^0$	3	3.87	$-1.2\Delta_0$
Mn^{4+}	$t_{2g}^3 e_g^0$	3	3.87	$-1.2\Delta_0$

18 (d) :



19. (d) : The relationship between k and T is given by Arrhenius equation, $k = Ae^{-E_a/RT}$. A is frequency factor E_a is the activation energy, R is universal gas constant and T is temperature in K. A plot of rate constant (k) versus temperature (T) shows an exponential increase.



21. (26) : $\kappa = 1.07 \times 10^6 \text{ S m}^{-1}$; $R = 0.243 \Omega$

$$G = \frac{1}{R} = \frac{1}{0.243} \Omega^{-1} \text{ or S}$$

$$\kappa = \frac{G \times l}{a} \Rightarrow \text{Cell constant} \left(\frac{l}{a} \right) = \frac{\kappa}{G} = \frac{1.07 \times 10^6}{1} \times 0.243 = 26 \times 10^4 \text{ m}^{-1}$$

22. (2) : $E = \frac{nhc}{\lambda}$

$$50 = \frac{n \times 6.63 \times 10^{-34} \times 3 \times 10^8}{795 \times 10^{-9}}$$

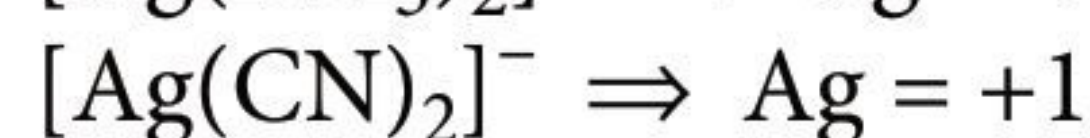
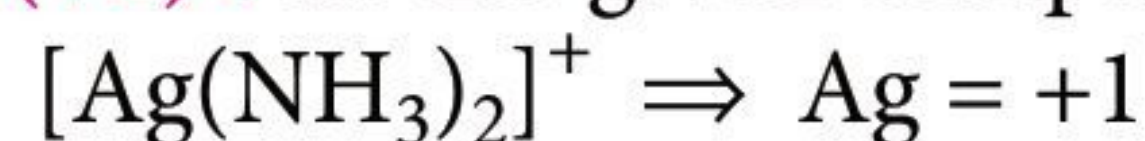
$$n = \frac{50 \times 795 \times 10^{-9}}{6.63 \times 10^{-34} \times 3 \times 10^8} = 2 \times 10^{20}$$

23. (64) : Molarity = $\frac{\text{Moles}}{\text{Volume in L}}$

$$\text{Moles} = \frac{80}{249.5}$$

$$\text{Molarity} = \frac{80}{249.5 \times 5} = 0.064 = 64 \times 10^{-3}$$

24. (+2) : In the given complex,



25. (5) : $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$

$$\Delta H = -57.8 \text{ kJ/mol}$$

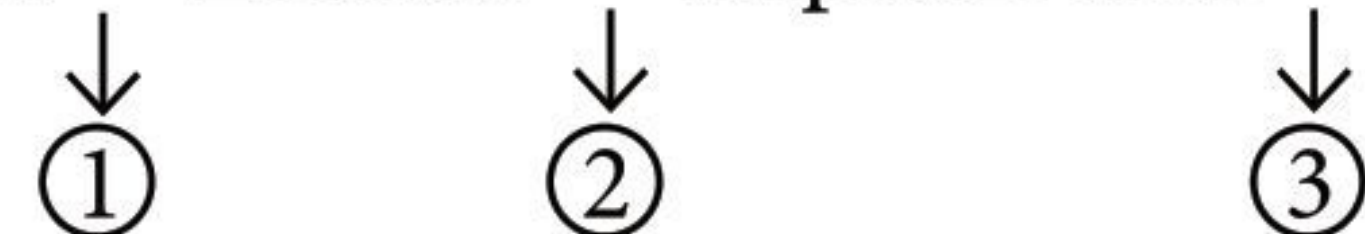
$$\Delta S = -176.0 \text{ J K}^{-1}$$

$$\Delta G = \Delta H - T\Delta S$$

$$= -57.8 \text{ kJ/mol} - (-176 \times 298 \times 10^{-3} \text{ kJ/mol})$$

$$= -57.8 \text{ kJ/mol} + 52.448 \text{ kJ/mol} = -5.35 \text{ kJ/mol}$$

26. (3) : Two amino acids combine together by peptide bonds.



27. (173) : $B_2^+ : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^1$

$$\mu = \sqrt{n(n+2)} = \sqrt{1(1+2)} = 1.73 = 173 \times 10^{-2} \text{ BM}$$

28. (2) : Moles of Na = $\frac{8}{23}$

$$\text{Number of atoms} = \frac{8 \times 6.02 \times 10^{23}}{23} = 2.09 \times 10^{23}$$

29. (2) : Initial mass of gas = 29 – 14.8 = 14.2 kg

Mass of gas used = 29 – 23 = 6 kg

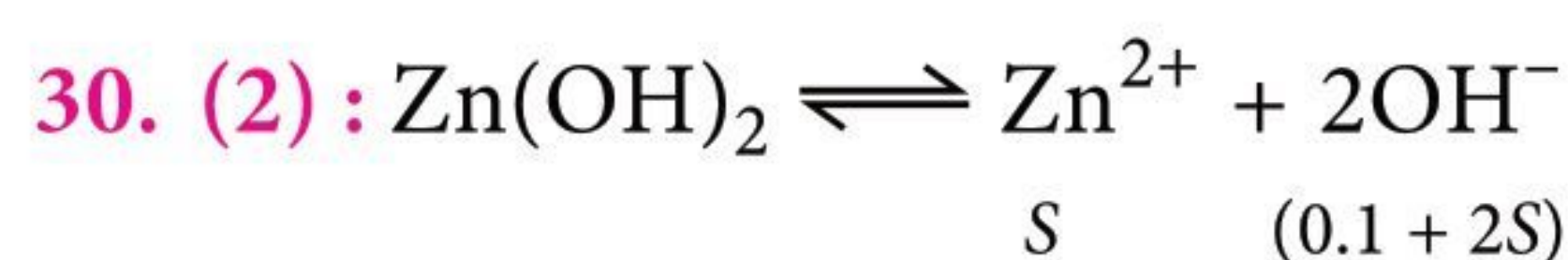
Gas left = 14.2 – 6 = 8.2 kg

$$PV = nRT \Rightarrow 3.47 \times V = \frac{14.2 \times 10^3}{M} \times RT \quad \dots(i)$$

$$P \times V = \frac{8.2 \times 10^3}{M} \times RT \quad \dots(ii)$$

From equations (i) and (ii)

$$\frac{3.47}{P} = \frac{14.2 \times 10^3}{8.2 \times 10^3} \Rightarrow P = \frac{8.2 \times 10^3 \times 3.47}{14.2 \times 10^3} = 2$$



The solubility of $Zn(OH)_2$ in 0.1 M NaOH is decreased due to common ion effect.

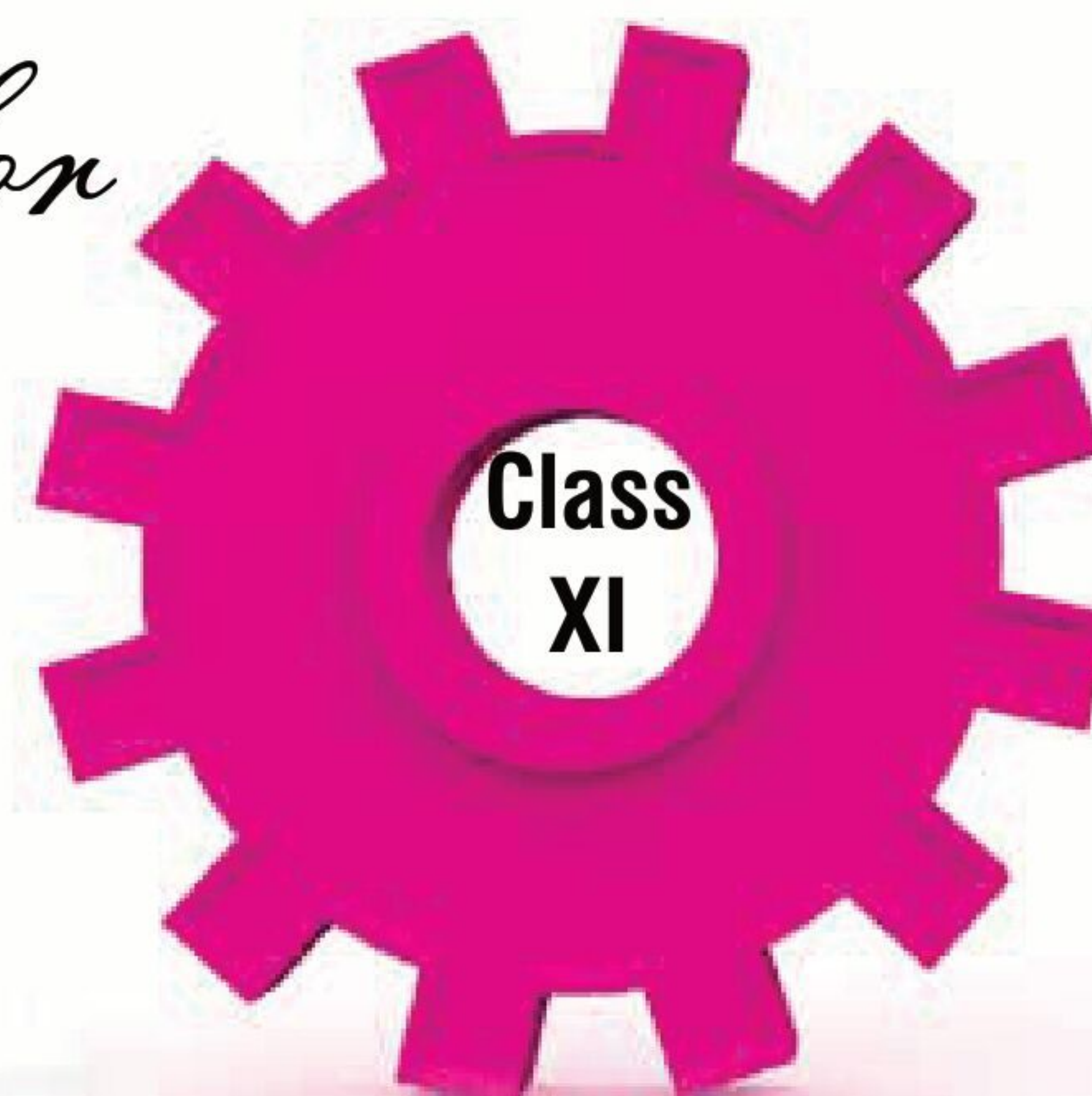
$$K_{sp} = S(0.1)^2 \text{ (as } 0.1 \gg 2S)$$

$$2 \times 10^{-20} = S \times 0.01$$

$$S = 2 \times 10^{-18}$$



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- Nuclear attraction is often the deciding control factor for the association of neutral molecules to a given metal ion. Which one of the following represents the correct order of stability of the ions? $[\text{Be}(\text{H}_2\text{O})_4]^{2+}$, $[\text{Mg}(\text{H}_2\text{O})_4]^{2+}$, $[\text{Ca}(\text{H}_2\text{O})_4]^{2+}$ and $[\text{Sr}(\text{H}_2\text{O})_4]^{2+}$
 (a) $[\text{Be}(\text{H}_2\text{O})_4]^{2+} > [\text{Sr}(\text{H}_2\text{O})_4]^{2+} > [\text{Mg}(\text{H}_2\text{O})_4]^{2+} > [\text{Ca}(\text{H}_2\text{O})_4]^{2+}$
 (b) $[\text{Ca}(\text{H}_2\text{O})_4]^{2+} > [\text{Mg}(\text{H}_2\text{O})_4]^{2+} > [\text{Be}(\text{H}_2\text{O})_4]^{2+} > [\text{Sr}(\text{H}_2\text{O})_4]^{2+}$
 (c) $[\text{Sr}(\text{H}_2\text{O})_4]^{2+} > [\text{Ca}(\text{H}_2\text{O})_4]^{2+} > [\text{Mg}(\text{H}_2\text{O})_4]^{2+} > [\text{Be}(\text{H}_2\text{O})_4]^{2+}$
 (d) $[\text{Be}(\text{H}_2\text{O})_4]^{2+} > [\text{Mg}(\text{H}_2\text{O})_4]^{2+} > [\text{Ca}(\text{H}_2\text{O})_4]^{2+} > [\text{Sr}(\text{H}_2\text{O})_4]^{2+}$
- For the reversible system; $X_{(g)} \rightleftharpoons Y_{(g)} + Z_{(g)}$, a quantity of X was heated at constant pressure P at a certain temperature. The equilibrium partial pressure of X was found to be $P/7$. What is the value of K_p at given temperature?
 (a) $6P/7$ (b) $9P/7$ (c) $36P/7$ (d) $6P$
- Iodine molecule dissociates into atoms after absorbing light of 4500 \AA . If one quantum of radiation is absorbed by each molecule, calculate the kinetic energy of iodine atoms (Bond energy of $\text{I}_2 = 240 \text{ kJ mol}^{-1}$)
 (a) $0.216 \times 10^{-19} \text{ J}$ (b) $0.532 \times 10^{-20} \text{ J}$
 (c) $0.732 \times 10^{-21} \text{ J}$ (d) $0.832 \times 10^{-24} \text{ J}$
- In which of the following ionization processes, the bond order has increased and the magnetic behaviour has changed?
 (a) $\text{NO} \rightarrow \text{NO}^+$ (b) $\text{O}_2 \rightarrow \text{O}_2^+$
 (c) $\text{N}_2 \rightarrow \text{N}_2^+$ (d) $\text{C}_2 \rightarrow \text{C}_2^+$
- The average speed at $T_1\text{K}$ and the most probable speed at $T_2\text{K}$ of CO_2 gas is $9 \times 10^4 \text{ cm sec}^{-1}$. What is the ratio of $T_2 : T_1$?
 (a) $5 : 4$ (b) $4 : 5$
 (c) $2 : 5$ (d) $1 : 3$
- Dilution processes of different aqueous solutions, with water, are given in List-I. The effects of dilution of the solutions on $[\text{H}^+]$ are given in List-II.
 (Note: Degree of dissociation (α) of weak acid and weak base is $\ll 1$; degree of hydrolysis of salt $\ll 1$; $[\text{H}^+]$ represents the concentration of H^+ ions)

List-I		List-II	
P.	(10 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 60 mL	1.	The value of $[H^+]$ does not change on dilution
Q.	(20 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 80 mL	2.	The value of $[H^+]$ changes to half of its initial value on dilution
R.	(20 mL of 0.1 M HCl + 20 mL of 0.1 M ammonia solution) diluted to 80 mL	3.	The value of $[H^+]$ changes to two times of its initial value on dilution
S.	10 mL saturated solution of $Ni(OH)_2$ in equilibrium with excess solid $Ni(OH)_2$ is diluted to 20 mL (solid $Ni(OH)_2$ is still present after dilution).	4.	The value of $[H^+]$ changes to $\frac{1}{\sqrt{2}}$ times of its initial value on dilution
		5.	The value of $[H^+]$ changes to $\sqrt{2}$ times of its initial value on dilution

Match each process given in List-I with one or more effect(s) in List-II.

The correct option is

- (a) $P \rightarrow 4; Q \rightarrow 2; R \rightarrow 3; S \rightarrow 1$
 (b) $P \rightarrow 4; Q \rightarrow 3; R \rightarrow 2; S \rightarrow 3$
 (c) $P \rightarrow 1; Q \rightarrow 4; R \rightarrow 5; S \rightarrow 3$
 (d) $P \rightarrow 1; Q \rightarrow 5; R \rightarrow 4; S \rightarrow 1$

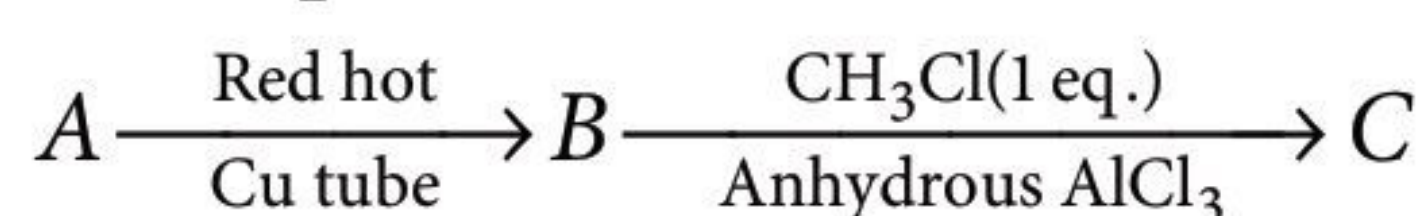
7. 0.257 g of an organic substance was heated with conc. H_2SO_4 and then distilled with excess of strong alkali. The ammonia gas evolved was absorbed in 50 mL of N/10 HCl which required 23.2 mL of N/10 NaOH for neutralisation at the end of the process. The percentage of nitrogen in the compound is
 (a) 14.6 (b) 18.0 (c) 17.0 (d) 15.5
8. The lattice energy of NaCl is 788 kJ mol^{-1} . This means that 788 kJ of energy is required
 (a) to separate one mole of solid NaCl into one mole of $Na_{(g)}$ and one mole of $Cl_{(g)}$ to infinite distance
 (b) to separate one mole of solid NaCl into one mole of $Na^+_{(g)}$ and one mole of $Cl^-_{(g)}$ to infinite distance

- (c) to convert one mole of solid NaCl into one mole of gaseous NaCl
 (d) to convert one mole of gaseous NaCl into one mole of solid NaCl

9. 0.4426 g of a metallic chloride was dissolved in water and solution made up to 100 mL. 50 mL of this solution required 1.02 g of $AgNO_3$ to precipitate the chloride completely. The specific heat of the metal was 0.057. What are the exact atomic weight and valency of the metal respectively?
 (a) 128.80, 3 (b) 120.30, 2
 (c) 150.70, 2 (d) 114.78, 3
10. The entropy change associated with the conversion of 1 kg of ice at 273 K to water vapours at 383 K is (specific heat of water liquid and water vapour are $4.2 \text{ kJ K}^{-1} \text{ kg}^{-1}$ and $2.0 \text{ kJ K}^{-1} \text{ kg}^{-1}$; heat of liquid fusion and vapourisation of water are 334 kJ kg^{-1} and 2491 kJ kg^{-1} , respectively).
 (log 273 = 2.436, log 373 = 2.572, log 383 = 2.583)
 (a) $2.64 \text{ kJ kg}^{-1} \text{ K}^{-1}$ (b) $9.26 \text{ kJ kg}^{-1} \text{ K}^{-1}$
 (c) $8.49 \text{ kJ kg}^{-1} \text{ K}^{-1}$ (d) $7.90 \text{ kJ kg}^{-1} \text{ K}^{-1}$
11. A hydrocarbon, 'X' (C_3H_4) decolourise bromine in carbon tetrachloride forming 'Y'. 'X' gave a red precipitate of a compound 'Z' with ammoniacal cuprous chloride and formed a carbonyl compound with dilute sulphuric acid in the presence of Hg^{2+} ions. X, Y and Z are respectively
 (a) $CH_2=C=CH_2$, $CH_2Br-CBr_2-CH_2Br$, $CH_3-C\equiv C-Cu$
 (b) $CH_3-C\equiv CH$, $CH_3-CBr_2-CHBr_2$, $CH_3-C\equiv C-Cu$
 (c) $CH_3-C\equiv CH$, $CH_3-CBr=CHBr$, $CH_2Cu-C\equiv CH$
 (d) $CH_2=C=CH_2$, $CH_2Br-CH=CHBr$, $CH_3-C\equiv C-Cu$
12. $SiCl_4 \xrightarrow{H_2O} (A) \xrightarrow{\Delta} (B) \xrightarrow[\text{heat}]{NaOH} (C)$.
 The compound C is
 (a) SiO_2 (b) Si
 (c) SiC (d) Na_2SiO_3
13. Which of the following statements is incorrect in the context of the B-F bond in BF_3 ?
 (a) All the three B-F bond lengths are equal and each of them is shorter than the sum of the covalent radii of boron and fluorine.
 (b) The bond energy of the B-F bond is very high, higher than for any other single bond.

- (c) The unusual shortness and high strength of the B–F bond may be explained by a $p\pi$ - $p\pi$ interaction between boron and fluorine atoms.
- (d) The unusual shortness and high strength of the bonds may be explained by a $p\pi$ - $d\pi$ interaction between the atoms of boron and fluorine.

14. In the following sequence of reactions the maximum number of atoms present in molecule 'C' in one plane is ____.



(A is a lowest molecular weight alkyne.)

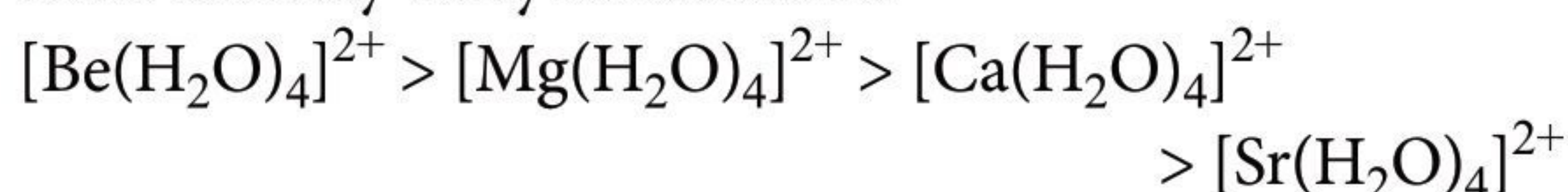
15. A 20.0 mL solution containing 0.2 g impure H_2O_2 reacts completely with 0.316 g of KMnO_4 in acid solution. The purity of H_2O_2 (in %) is _____.
(mol. wt. of $\text{H}_2\text{O}_2 = 34$; mol. wt. of $\text{KMnO}_4 = 158$)

SOLUTIONS

1. (d): The degree of hydration and the amount of hydration energy decreases as the size of the ion increases from Be^{2+} to Sr^{2+} .

	Be^{2+}	<	Mg^{2+}	<	Ca^{2+}	<	Sr^{2+}
Hydration Energy (kJ mol^{-1})	-2494		-1921		-1577		-1443

Thus stability of hydrated ion is



2. (b): For $X_{(g)} \rightleftharpoons Y_{(g)} + Z_{(g)}$;

$$P'_x = P \frac{(a-x)}{(a+x)} = \frac{P}{7}$$

$$\therefore 7a - 7x = a + x,$$

$$x = \frac{6a}{8} = \frac{3a}{4}$$

$$\text{Also, } K_p = \frac{x^2}{(a-x)} \times \left[\frac{P}{a+x} \right] = \frac{9a^2 \times 4}{16 \times a} \times \frac{P \times 4}{7a} = \frac{9P}{7}$$

3. (a): Energy given to I_2 molecule = $\frac{hc}{\lambda}$

$$= \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{4500 \times 10^{-10}} = 4.417 \times 10^{-19} \text{ J}$$

Energy used for breaking up of I_2 molecule

$$= \frac{240 \times 10^3}{6.023 \times 10^{23}} = 3.984 \times 10^{-19} \text{ J}$$

\therefore Energy used in imparting K.E. to two I atoms
 $= (4.417 \times 10^{-19} - 3.984 \times 10^{-19}) \text{ J} = 0.433 \times 10^{-19} \text{ J}$
 K.E. per atom = $0.216 \times 10^{-19} \text{ J}$

4. (a): $\text{NO} \longrightarrow \text{NO}^+$
 B.O. = 2.5 3
 Paramagnetic Diamagnetic
- $\text{O}_2 \longrightarrow \text{O}_2^+$
 B.O. = 2.0 2.5
 Paramagnetic Paramagnetic
- $\text{N}_2 \longrightarrow \text{N}_2^+$
 B.O. = 3 2.5
 Diamagnetic Paramagnetic
- $\text{C}_2 \longrightarrow \text{C}_2^+$
 B.O. = 2.0 1.5
 Diamagnetic Paramagnetic

5. (a): Average speed at $T_1 \text{ K} = \sqrt{\frac{8RT_1}{\pi M}}$

$$\text{Most probable speed at } T_2 \text{ K} = \sqrt{\frac{2RT_2}{M}}$$

$$\text{According to question, } \sqrt{\frac{8RT_1}{\pi M}} = \sqrt{\frac{2RT_2}{M}} = 9 \times 10^4$$

$$\text{i.e., } \sqrt{\frac{8T_1}{\pi}} = \sqrt{2T_2} \quad \text{or} \quad \frac{8T_1}{\pi} = 2T_2$$

$$\frac{8}{\pi \times 2} = \frac{T_2}{T_1} \Rightarrow \frac{T_2}{T_1} = \frac{5}{4}$$

6. (d): (P) $[\text{CH}_3\text{COOH}]_{\text{old}} = \frac{20 \times 0.1 - 10 \times 0.1}{30} = \frac{1}{30}$

$$[\text{CH}_3\text{COO}^-]_{\text{new}} = \frac{1}{30}$$

Buffer with $[\text{Salt}] = [\text{Acid}]$

pH does not change on dilution (P) \rightarrow (1)

$$(Q) [\text{CH}_3\text{COO}^-]_{\text{old}} = \frac{20 \times 0.1}{40} = \frac{2}{40}$$

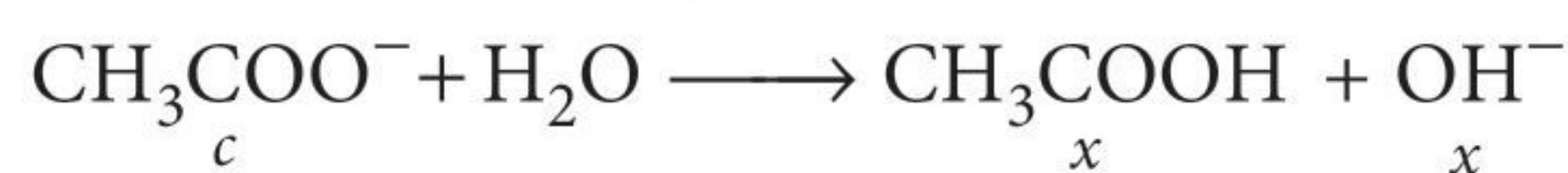


COMIC CAPSULE

Water is a Polar Molecule.



$$[\text{CH}_3\text{COO}^-]_{\text{new}} = \frac{2}{80}$$



$$K_h = \frac{x^2}{c} = \frac{[\text{OH}^-]_{\text{old}}^2}{2/40} = \frac{[\text{OH}^-]_{\text{new}}^2}{2/80}$$

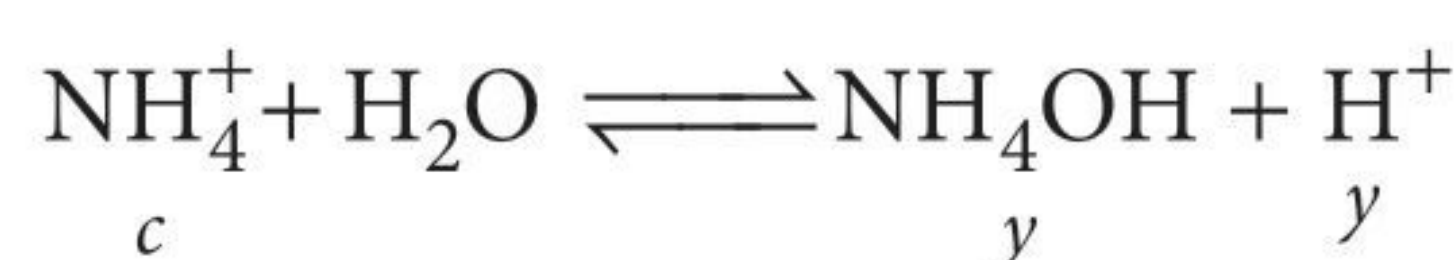
$$\text{or, } [\text{OH}^-]_{\text{new}}^2 = \frac{[\text{OH}^-]_{\text{old}}^2}{2}$$

$$\text{or, } [\text{OH}^-]_{\text{new}} = \frac{[\text{OH}^-]_{\text{old}}}{\sqrt{2}}$$

$$\therefore [\text{H}^+]_{\text{new}} = \sqrt{2}[\text{H}^+]_{\text{old}}$$

(Q) \rightarrow (5)

$$(R) [\text{NH}_4^+]_{\text{old}} = \frac{20 \times 0.1}{40} = \frac{2}{40}, [\text{NH}_4^+]_{\text{new}} = \frac{2}{80}$$

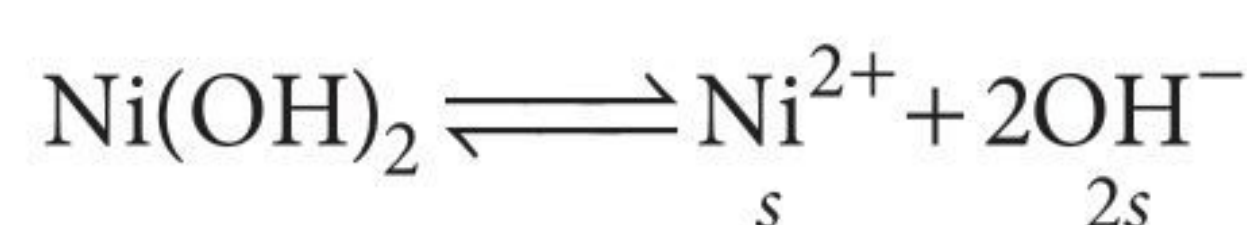


$$K_h = \frac{y^2}{c} = \frac{[\text{H}^+]_{\text{old}}^2}{2/40} = \frac{[\text{H}^+]_{\text{new}}^2}{2/80}$$

$$\text{or } [\text{H}^+]_{\text{new}}^2 = \frac{[\text{H}^+]_{\text{old}}^2}{2} \Rightarrow [\text{H}^+]_{\text{new}} = \frac{[\text{H}^+]_{\text{old}}}{\sqrt{2}}$$

(R) \rightarrow (4)

(S) For a saturated solution,



$$K_{sp} = s \times (2s)^2 = 4s^3$$

$$s = [\text{OH}^-] = \sqrt[3]{\frac{K_{sp}}{4}}$$

Irrespective of volume of solution, $[\text{H}^+]$ remains constant.

(S) \rightarrow (1)

7. (a): Volume of $\frac{N}{10}$ HCl taken = 50 mL

Volume of $\frac{N}{10}$ NaOH used for neutralisation of unused acid = 23.2 mL

$$\text{Now } N_1 V_1 (\text{NaOH}) = N_2 V_2 (\text{HCl})$$

$$23.2 \text{ mL of } \frac{N}{10} \text{ NaOH} \equiv V_2 \text{ mL of } \frac{N}{10} \text{ HCl}$$

$$\therefore \text{Volume of } \frac{N}{10} \text{ HCl unused} = 23.2 \text{ mL}$$

$$\therefore \text{Volume of } \frac{N}{10} \text{ HCl required for neutralisation of } \text{NH}_3 = 50 - 23.2 = 26.8 \text{ mL}$$

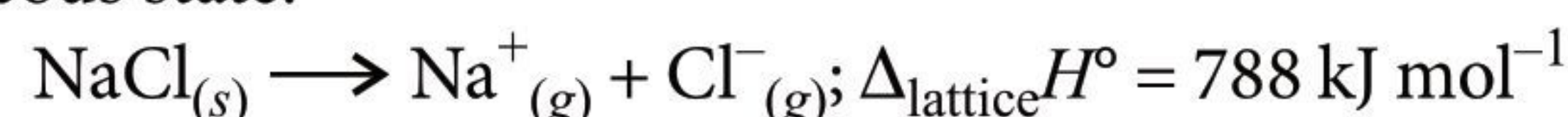
$$26.8 \text{ mL of } \frac{N}{10} \text{ HCl} = 26.8 \text{ mL of } \frac{N}{10} \text{ NH}_3$$

1000 mL of 1 N NH_3 solution contains nitrogen = 14 g

$$26.8 \text{ mL of } \frac{N}{10} \text{ NH}_3 \text{ solution contains nitrogen} = \frac{14 \times 26.8}{10 \times 1000}$$

$$\text{Percentage of nitrogen} = \frac{14 \times 26.8 \times 100}{10 \times 1000 \times 0.257} = 14.6\%$$

8. (b): Lattice energy is the energy required to separate 1 mole of an ionic compound into its ions in gaseous state.



9. (d): Let the equivalent weight of metal be E

$$\frac{\text{Weight of metal chloride}}{\text{Weight of silver nitrate}} = \frac{\text{Eq. wt. of metal chloride}}{\text{Eq. wt. of silver nitrate}}$$

$$\frac{0.4426}{1.02} = \frac{E + 35.5}{170} \therefore E = 38.26$$

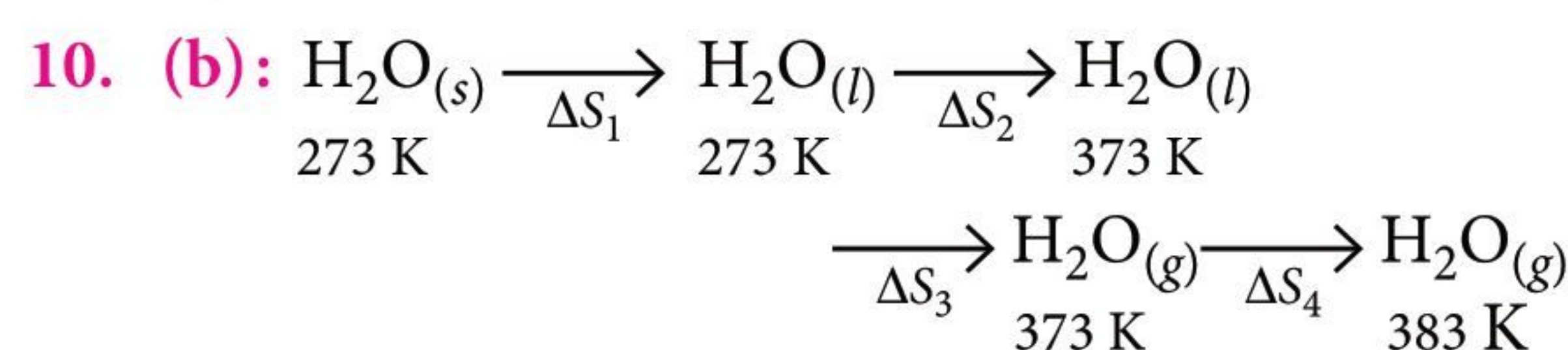
According to Dulong Petit's rule :

$$\text{Atomic wt} \times \text{Sp. heat} = 6.4$$

$$\text{Atomic wt.} = \frac{6.4}{0.057} = 112.3$$

$$\therefore \text{Valency} = \frac{\text{Atomic wt.}}{\text{Eq. wt.}} = \frac{112.3}{38.26} = 3$$

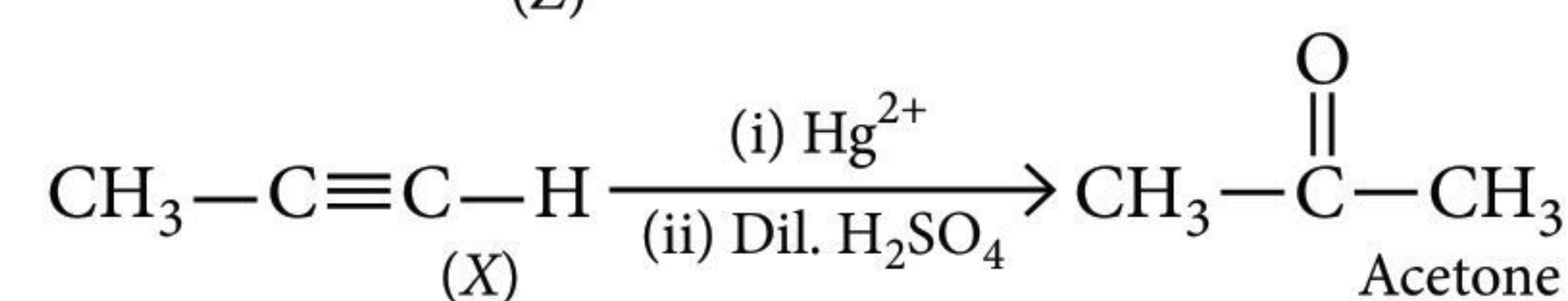
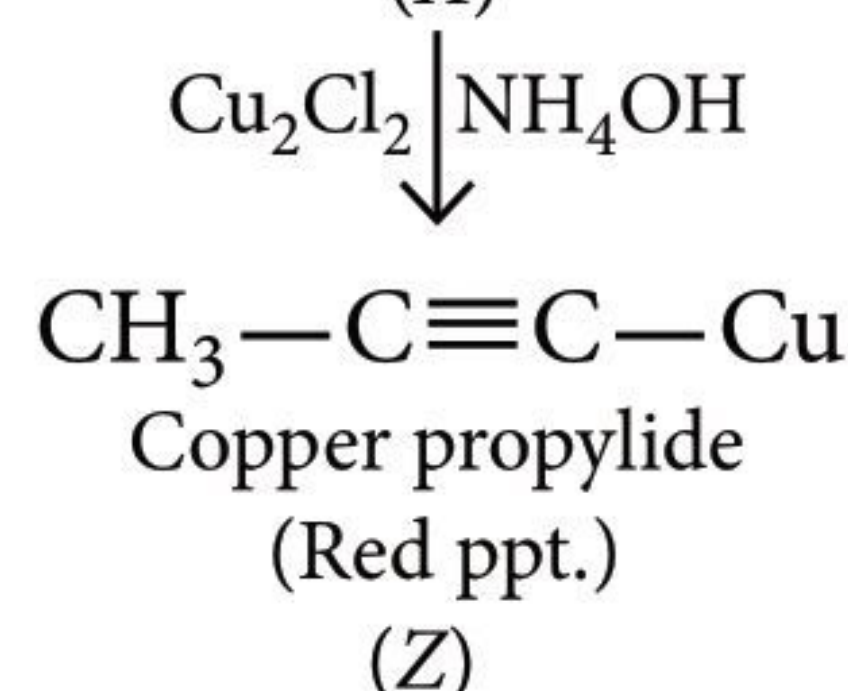
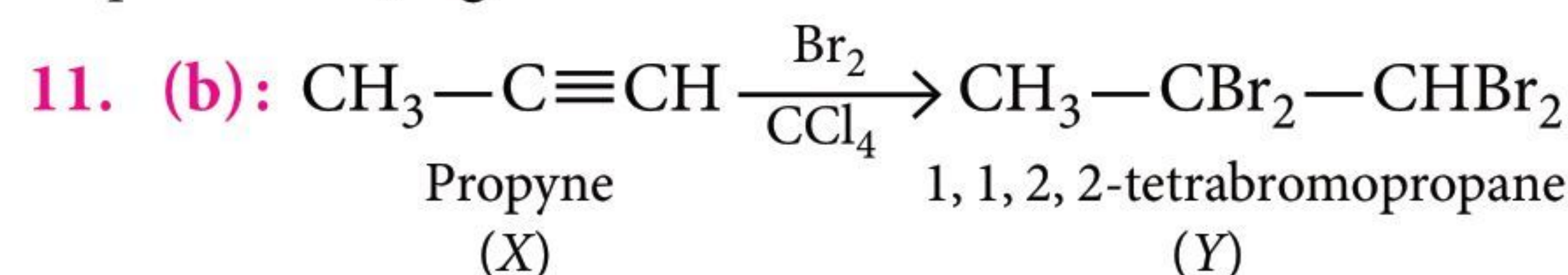
$$\text{Hence, exact atomic wt.} = 38.26 \times 3 = 114.78$$



$$\Delta S_1 = \frac{\Delta H_{\text{fus}}}{273} = \frac{334}{273} = 1.22; \Delta S_2 = 4.2 \ln \left(\frac{373}{273} \right) = 1.31$$

$$\Delta S_3 = \frac{\Delta H_{\text{vap}}}{373} = \frac{2491}{373} = 6.67; \Delta S_4 = 2.0 \ln \left(\frac{383}{373} \right) = 0.05$$

$$\Delta S_T = 9.26 \text{ kJ kg}^{-1} \text{ K}^{-1}$$



The Nobel Prize in Chemistry 2021

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Chemistry 2021 to **Benjamin List** affiliated to Max-Planck-Institut für Kohlenforschung, Mülheim an der Ruhr, Germany and **David W.C. MacMillan** affiliated to Princeton University, USA "for the development of asymmetric organocatalysis".

An ingenious tool for building molecules

Building molecules is a difficult art. Benjamin List and David MacMillan have been awarded the Nobel Prize in Chemistry 2021 for their development of a precise new tool for molecular construction: organocatalysis. This has had a great impact on pharmaceutical research, and has made chemistry greener.

Many research areas and industries are dependent on chemists' ability to construct molecules that can form elastic and durable materials, store energy in batteries or inhibit the progression of diseases. This work requires "catalysts", which are substances that control and accelerate chemical reactions, without becoming part of the final product. For example, catalysts in cars transform toxic substances in exhaust fumes to harmless molecules. Our bodies also contain thousands of catalysts in the form of enzymes, which chisel out the molecules necessary for life.

Catalysts are thus fundamental tools for chemists, but researchers long believed that there were, in principle, just two types of catalysts available: metals and enzymes. **Benjamin List** and **David MacMillan** have been awarded the Nobel Prize in Chemistry 2021 because in 2000 they, independent of each other, developed a third type of catalysis. It is called asymmetric organocatalysis and builds upon small organic molecules.

"This concept for catalysis is as simple as it is ingenious, and the fact is that many people have wondered why we didn't think of it earlier," says Johan Åqvist, who is chair of the Nobel Committee for Chemistry.

Organic catalysts have a stable framework of carbon atoms, to which more active chemical groups can attach. These often contain common elements such as oxygen, nitrogen, sulphur or phosphorus. This means that these catalysts are both environmentally friendly and cheap to produce.

The rapid expansion in the use of organic catalysts is primarily due to their ability to drive asymmetric catalysis. When molecules are being built, situations often occur where two different molecules can form, which – just like our hands – are each other's mirror image. Chemists will often only want one of these, particularly when producing pharmaceuticals.

Organocatalysis has developed at an astounding speed since 2000. Benjamin List and David MacMillan remain leaders in the field, and have shown that organic catalysts can be used to drive multitudes of chemical reactions. Using these reactions, researchers can now more efficiently construct anything from new pharmaceuticals to molecules that can capture light in solar cells. In this way, organocatalysts are bringing the greatest benefit to humankind.

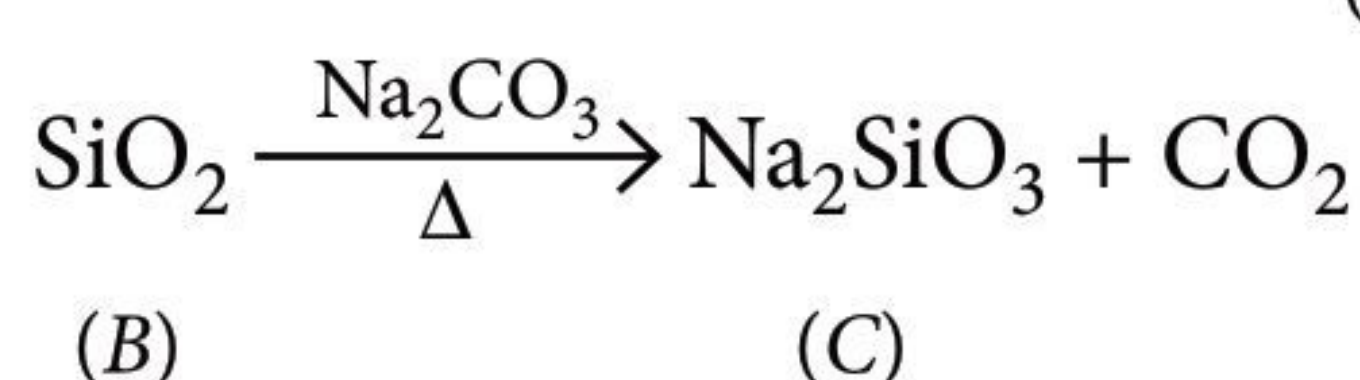
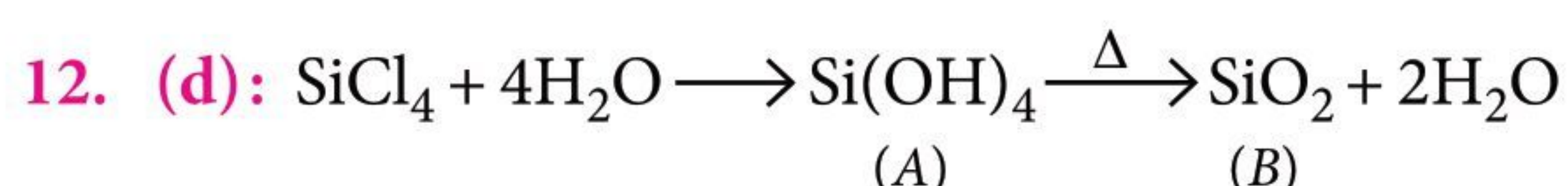
For more details visit www.nobelprize.org



Benjamin List
Prize share : 1/2

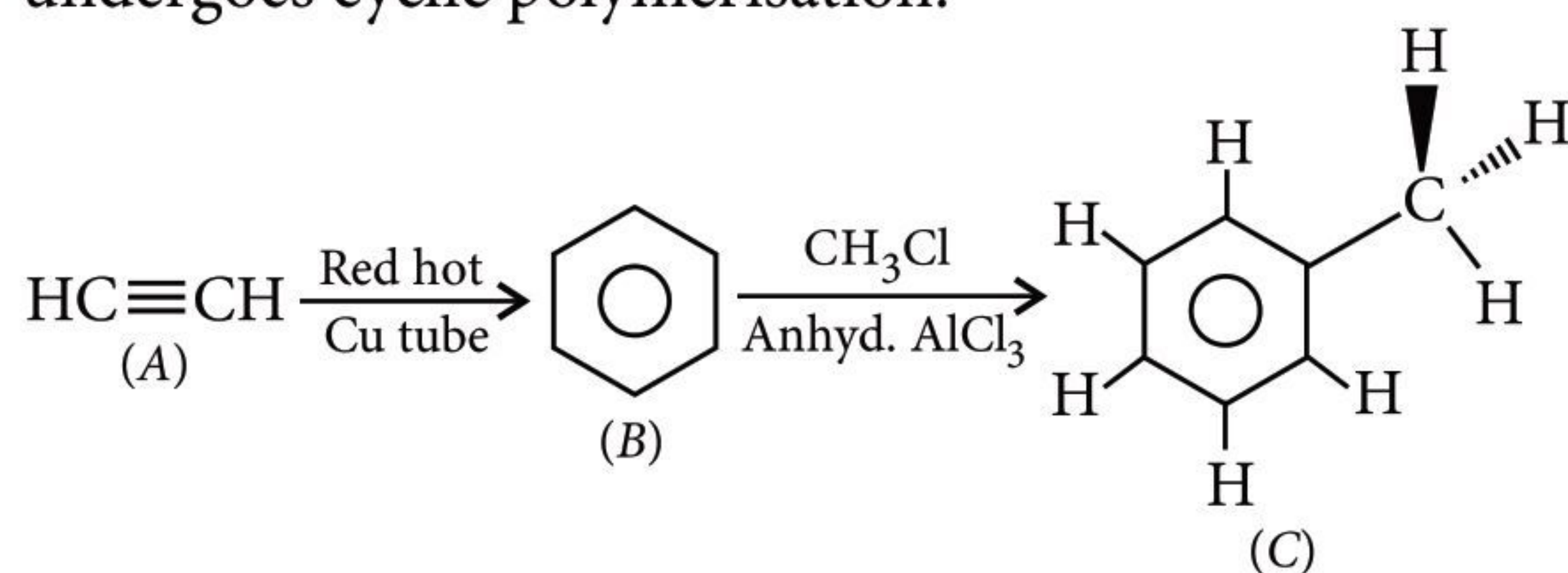


David W.C. Mac Millan
Prize share : 1/2



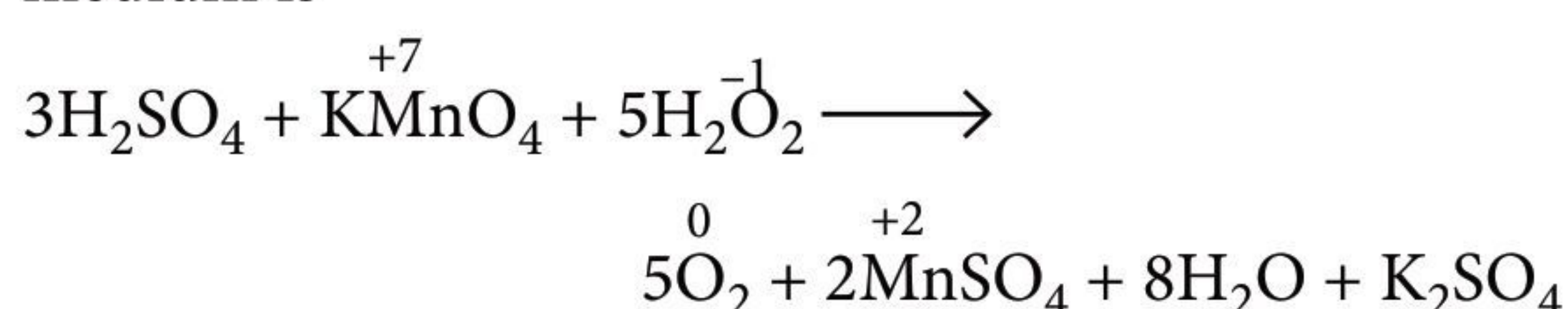
13. (d)

14. (13) : The lowest molecular weight alkyne is ethyne $\text{HC}\equiv\text{CH}$, which on passing through red hot Cu tube undergoes cyclic polymerisation.



Thus, maximum number of atoms in one plane = 13.

15. (85) : Reaction of H_2O_2 with KMnO_4 in acidic medium is



Valency factor for $\text{H}_2\text{O}_2 = 2$

Valency factor for $\text{KMnO}_4 = 5$

$$\left[\frac{x}{34} \right] \times 2 = \frac{0.316}{158} \times 5$$

$$\Rightarrow x = \frac{0.316 \times 5 \times 34}{158 \times 2} = 0.17 \text{ g}$$

$$\% \text{ Purity} = \frac{\text{Weight of pure substance}}{\text{Weight of given sample}} \times 100$$

$$= \frac{0.17}{0.2} \times 100 = 85\%$$



for NEET/JEE

BRUSH UP

CLASS-XI

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Unit
5

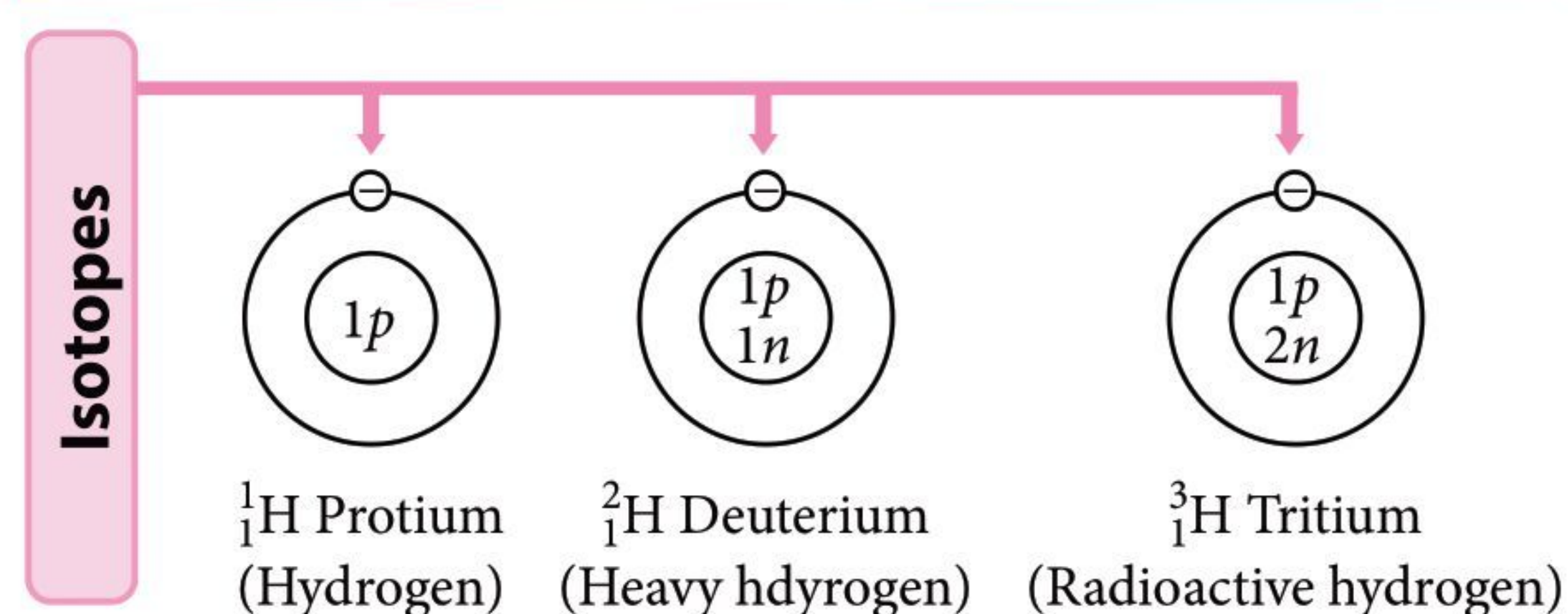
Hydrogen | The s-Block Elements

Hydrogen

POSITION OF HYDROGEN IN THE PERIODIC TABLE

- $H_1^{1.008}$: Electronic configuration $1s^1$
- Hydrogen is the first element of the periodic table and its position is anomalous.
- It resembles alkali metals w.r.t. electronic configuration, electropositive character, valency, oxidation state, combination with electronegative elements and liberation at cathode.
- It resembles halogens w.r.t. electronic configuration (one electron less than the nearest noble gas configuration), ionisation energy, electronegative character, oxidation state, diatomic nature and liberation at anode.
- It does not have metallic characteristics at ordinary temperature and pressure but under very high pressure, it is expected to behave like a metal.
- H^+ has very small size ($\sim 1.5 \times 10^{-3}$ pm) as compared to normal atomic and ionic sizes of 50 to 220 pm. It cannot exist freely and is always associated with other atoms or molecules.

ISOTOPES



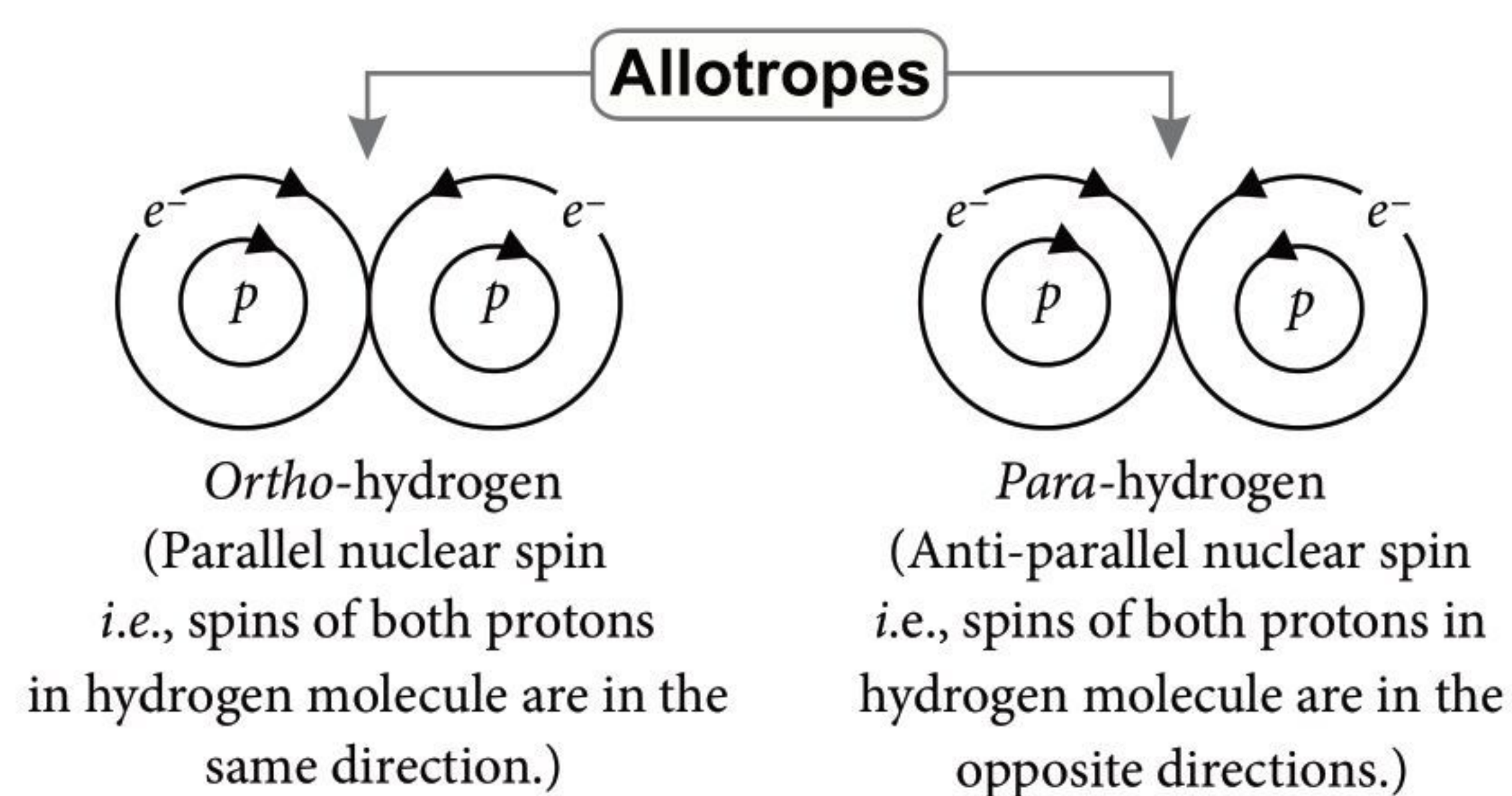
Bond Energy and Reactivity

Bond energy : $H_2 < D_2 < T_2$

Reactivity : $H_2 > D_2 > T_2$

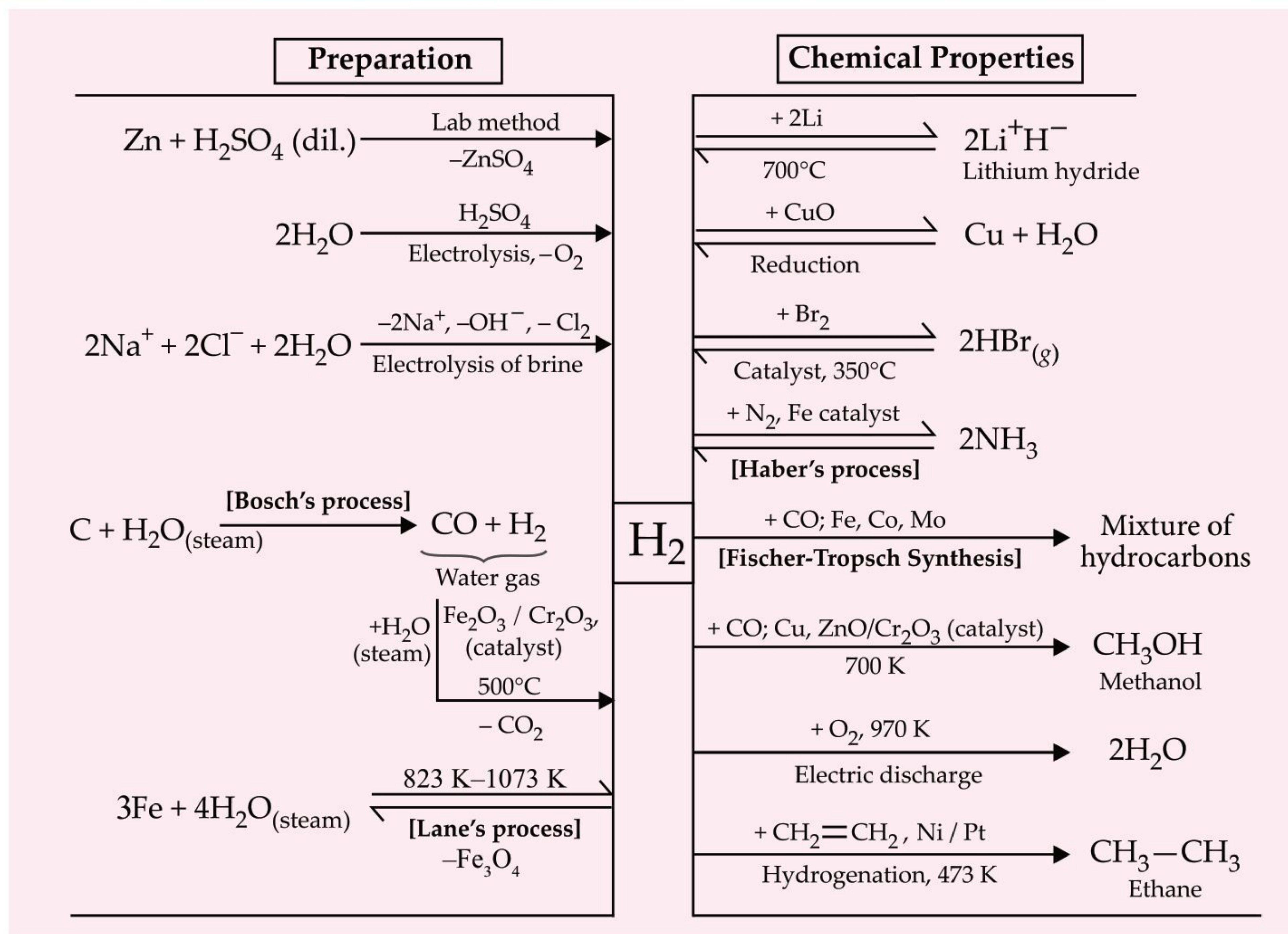
- The difference in the properties of isotopes which arises due to difference in their atomic masses is called isotopic effect.

ALLOTROPES



- At room temperature, ordinary hydrogen contains 75% *ortho*-hydrogen and 25% *para*-hydrogen. As the temperature decreases, the percentage of *ortho* hydrogen in the mixture decreases. Pure *para* hydrogen can be prepared by cooling nearly to absolute zero but pure *ortho* hydrogen is quite difficult to prepare.
- Stability : *Ortho* hydrogen > *Para* hydrogen.
- Differences in physical properties of both is because of differences in internal energy of both.
- Internal energy of *ortho* H_2 > *para* H_2 .

PREPARATION AND PROPERTIES OF HYDROGEN



HYDRIDES

- Dihydrogen, under certain reaction conditions, combines with almost all elements except noble gases to form binary compounds called hydrides. If 'E' is the symbol of an element, then hydride can be expressed as EH_x (e.g., MgH_2) or E_mH_n (e.g., B_2H_6).

Classification of Hydrides

Ionic hydrides	<p>These are formed by transfer of electrons from most of the <i>s</i>-block elements (electropositive metals) to hydrogen atom. e.g.,</p> $2\text{Li}_{(\text{s})} + \text{H}_{2(\text{g})} \xrightarrow{873 \text{ K}} 2\text{LiH}_{(\text{s})}$ $2\text{Na}_{(\text{s})} + \text{H}_{2(\text{g})} \xrightarrow{673 \text{ K}} 2\text{NaH}_{(\text{s})}$
Molecular or covalent hydrides	<p>Compounds of hydrogen with <i>p</i>-block elements and some <i>s</i>-block elements (Be & Mg). In some cases partly covalent and partly ionic character is found, e.g., HF.</p> $\text{N}_2 + 3\text{H}_2 \xrightarrow{\text{catalyst, 750 K}} 2\text{NH}_3$ $\text{CaC}_2 + 2\text{H}_2\text{O} \longrightarrow \text{Ca}(\text{OH})_2 + \text{C}_2\text{H}_2$

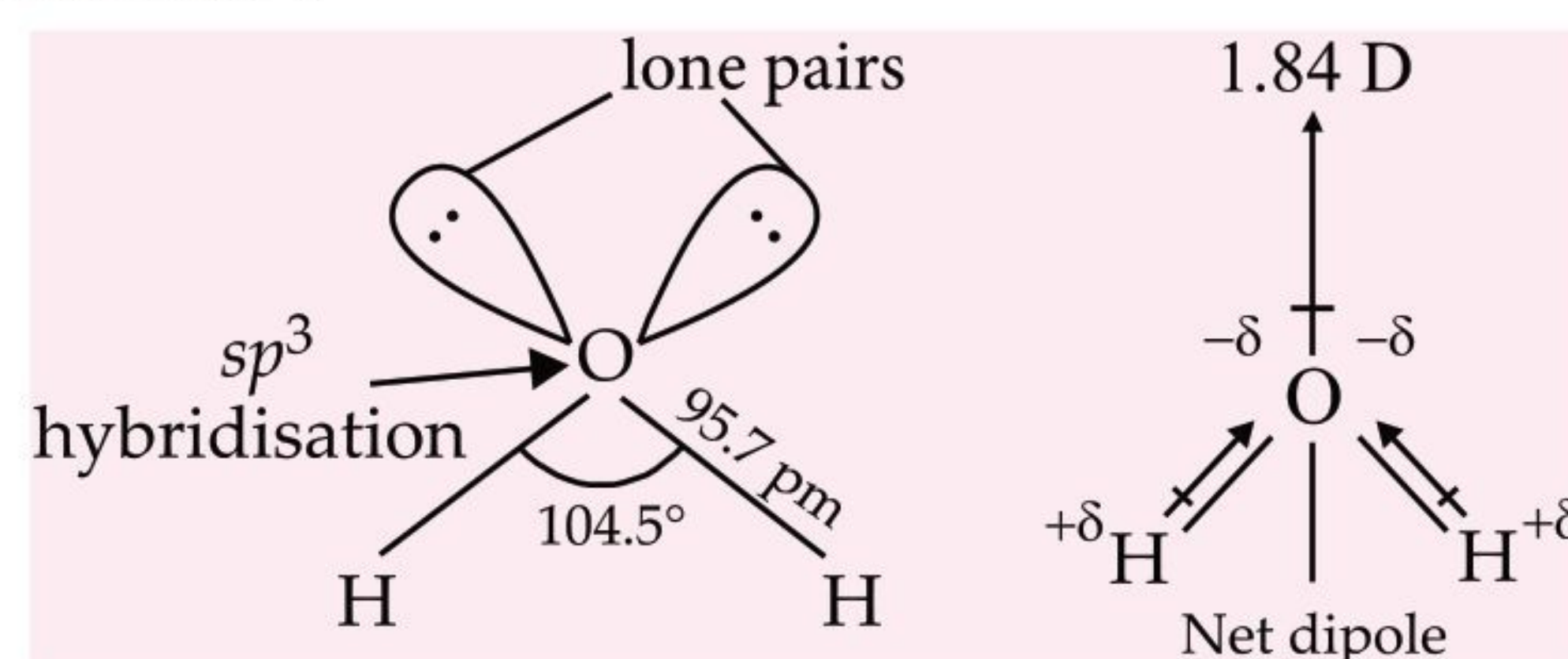
Metallic or interstitial hydrides

Compounds of hydrogen with *d*-block and *f*-block metals. These are non-stoichiometric and show electric conduction.

- Elements of groups 7, 8 and 9 do not form hydrides. This region of periodic table is referred to as hydride gap.

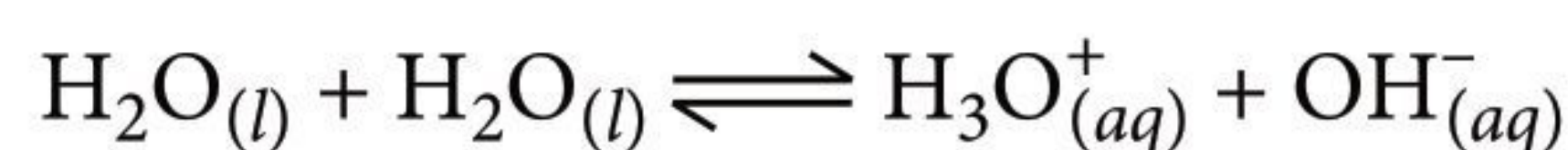
WATER

- Water is the principal constituent of earth's surface.
- Structure :**

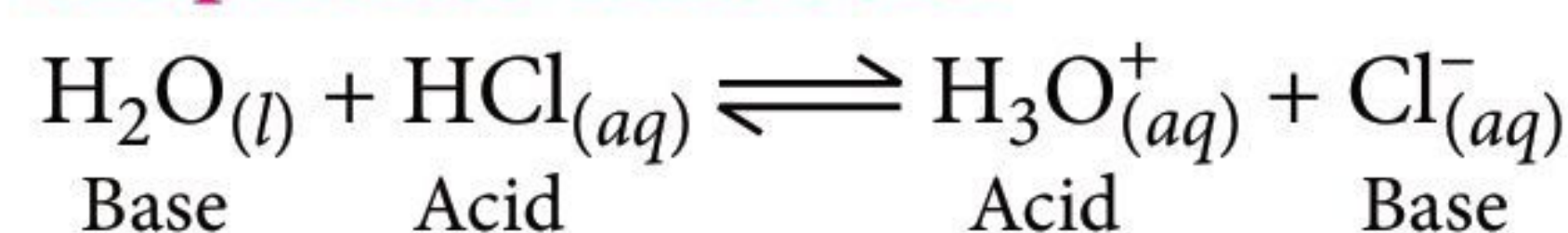


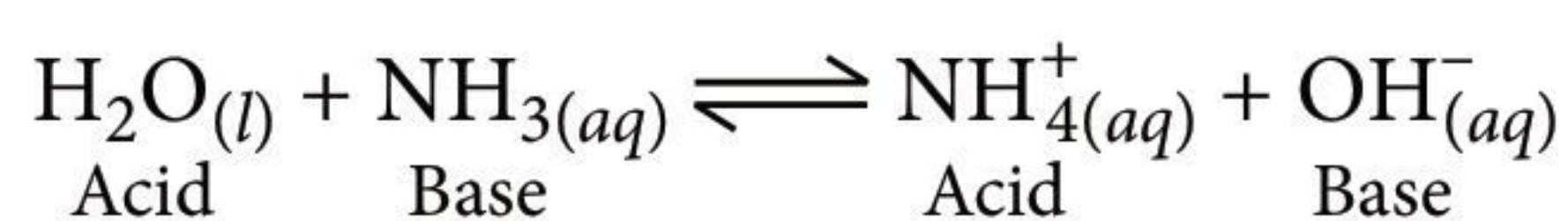
CHEMICAL PROPERTIES OF WATER

- Self-ionisation of water :**

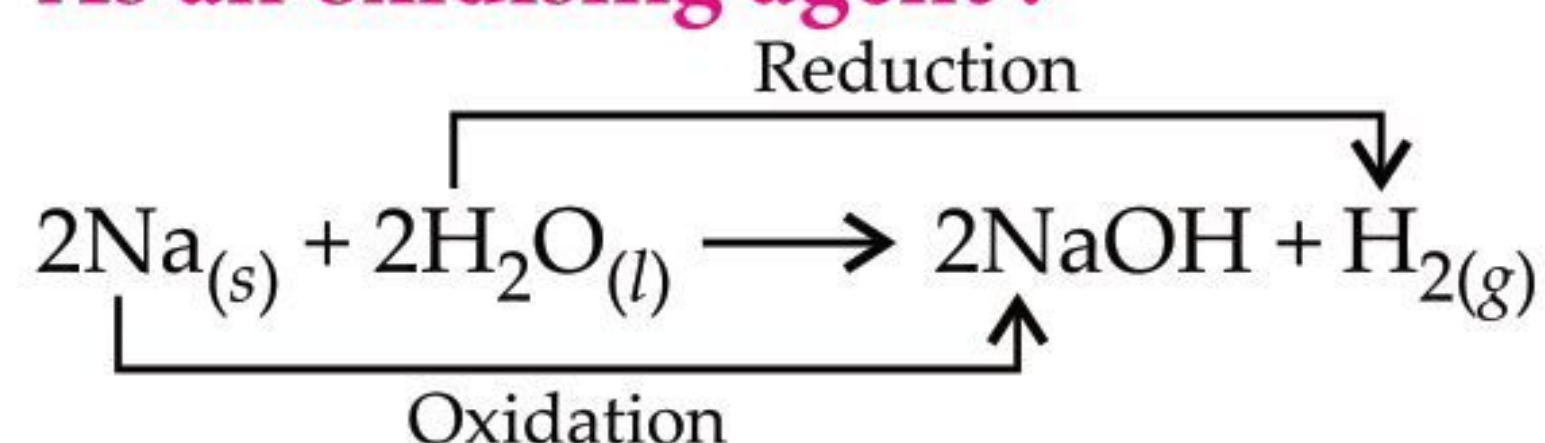


- Amphoteric character :**

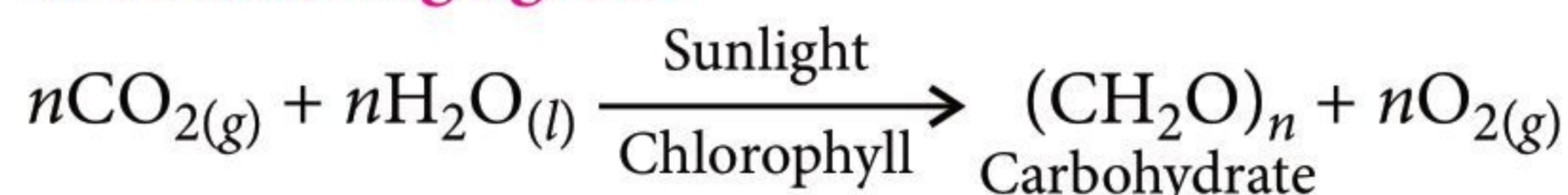




- **As an oxidising agent :**



- **As a reducing agent :**



HEAVY WATER (D₂O)

- Discovered by Urey.
- It is obtained from ordinary water by prolonged electrolysis.
- It is colourless, odourless and tasteless liquid. In India, heavy water plants are located at Nangal, Rourkela, Trombay, Namrup, Neyveli and Naharkatiya.

CHEMICAL PROPERTIES OF HEAVY WATER

- $\text{SO}_3 + \text{D}_2\text{O} \longrightarrow \text{D}_2\text{SO}_4$
Deutero sulphuric acid
- $\text{Al}_4\text{C}_3 + 12\text{D}_2\text{O} \longrightarrow 3\text{CD}_4 + 4\text{Al(OD)}_3$
Aluminium carbide Deutero methane
- $\text{CaC}_2 + 2\text{D}_2\text{O} \longrightarrow \text{DC}\equiv\text{CD} + \text{Ca(OD)}_2$
Calcium carbide Deutero ethyne

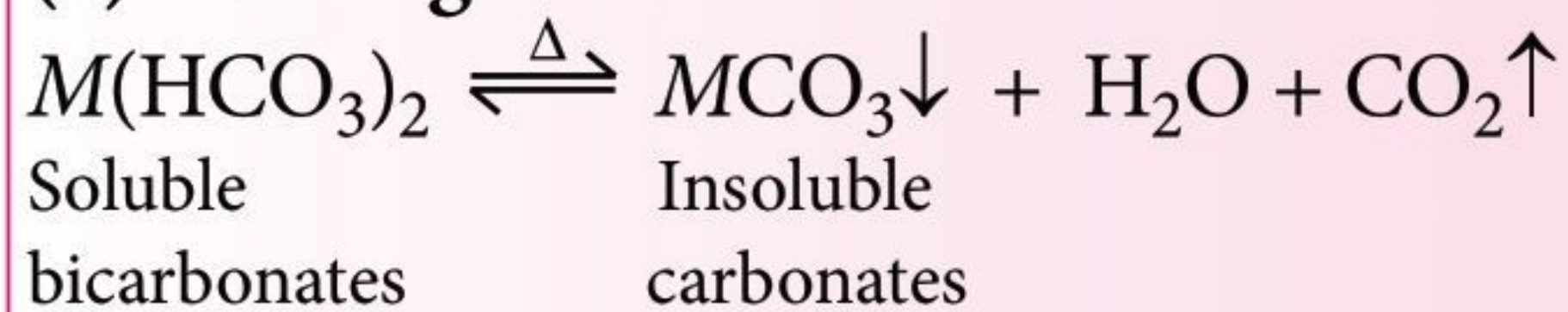
HARD AND SOFT WATER

- **Soft water :** Water which forms lather with soap easily is called *soft water*.
- **Hard water :** Water which does not form lather with soap easily and hence is unfit for washing is called *hard water*.

Types of Hard Water

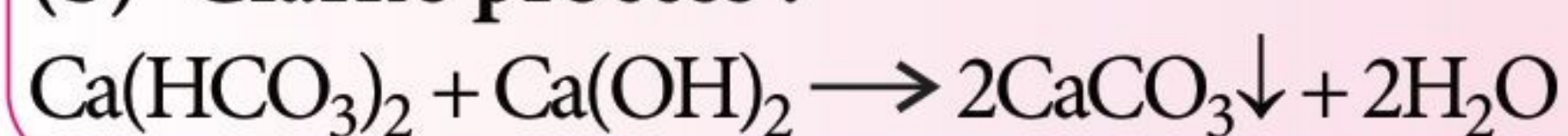
Temporary hardness : It is due to the presence of bicarbonates of Ca and Mg. It can be removed by

(a) **Boiling :**

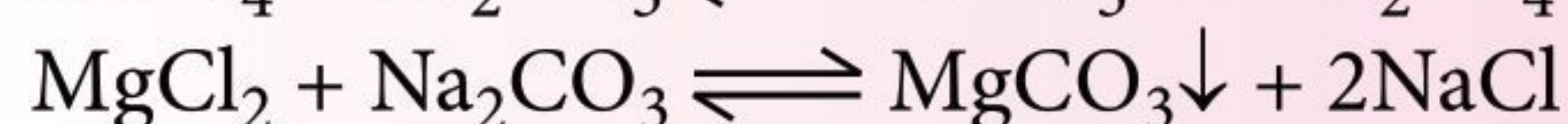
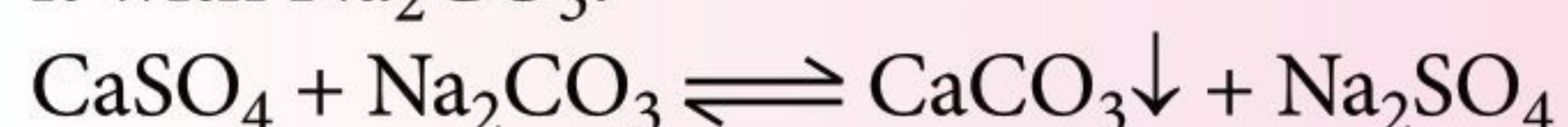


Here, $M = \text{Mg or Ca}$

(b) **Clark's process :**



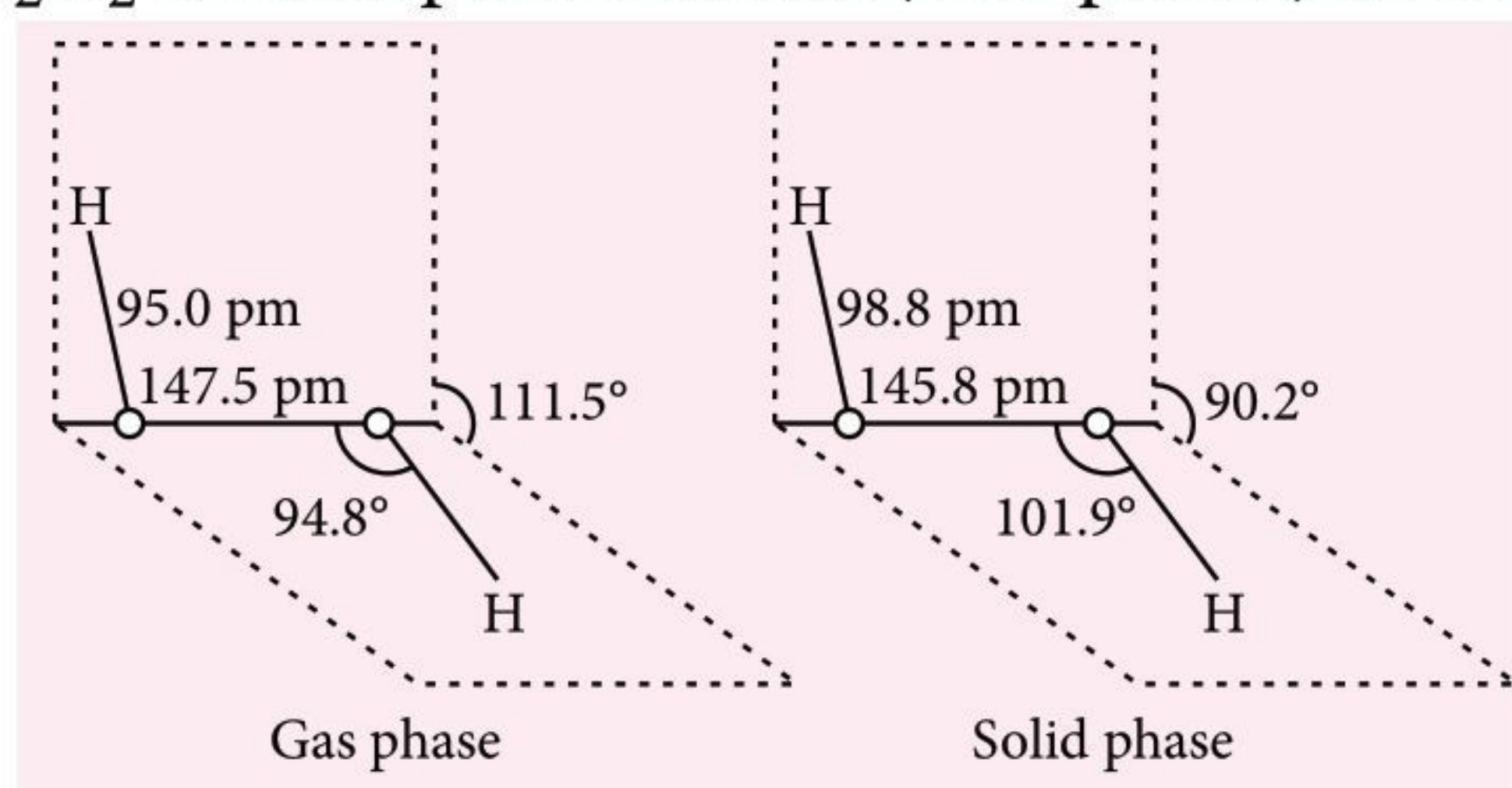
Permanent hardness : It is due to the presence of soluble chlorides and sulphates of Ca and Mg. It can be removed by treating it with Na_2CO_3 .



Removal of permanent hardness is affected by ion exchangers like zeolite, permutit and synthetic resins, etc.

HYDROGEN PEROXIDE OR OXYGENATED WATER (H₂O₂)

- It is the hydride of oxygen.
- Its boiling point is higher than H_2O due to the presence of stronger intermolecular hydrogen bonding than in water.
- **Structure :**
 H_2O_2 has an open book like (non-planar) structure.





NEET

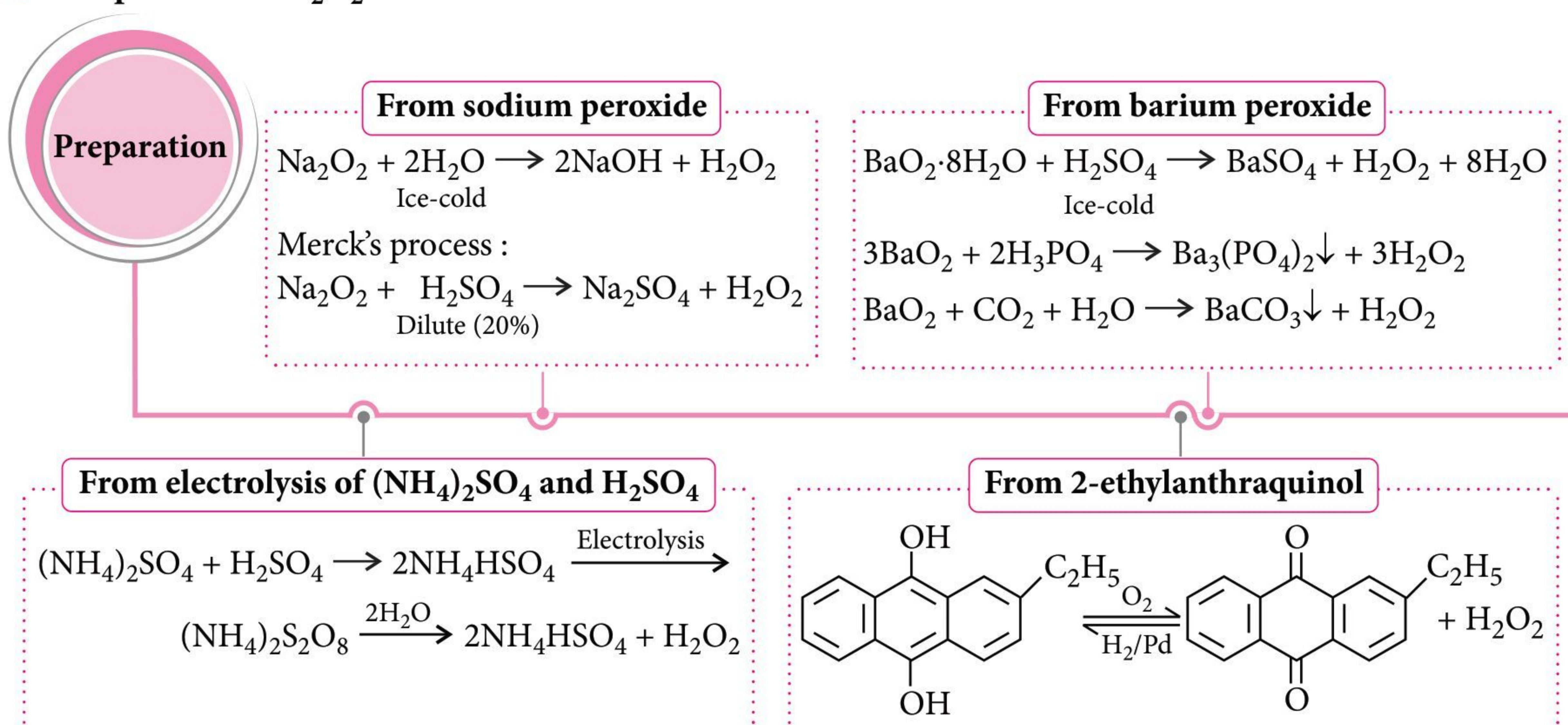
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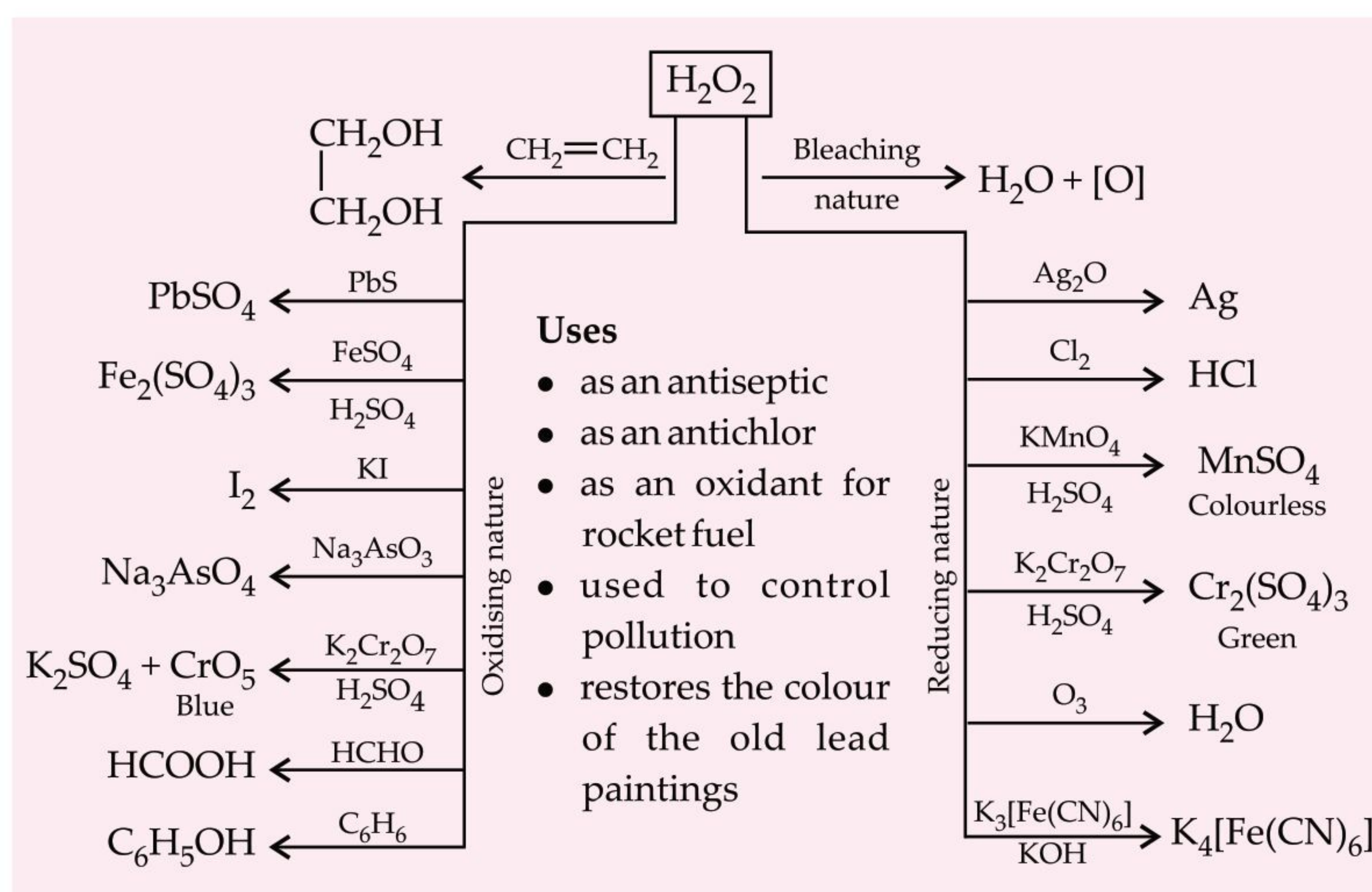
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• **Preparation of H_2O_2**

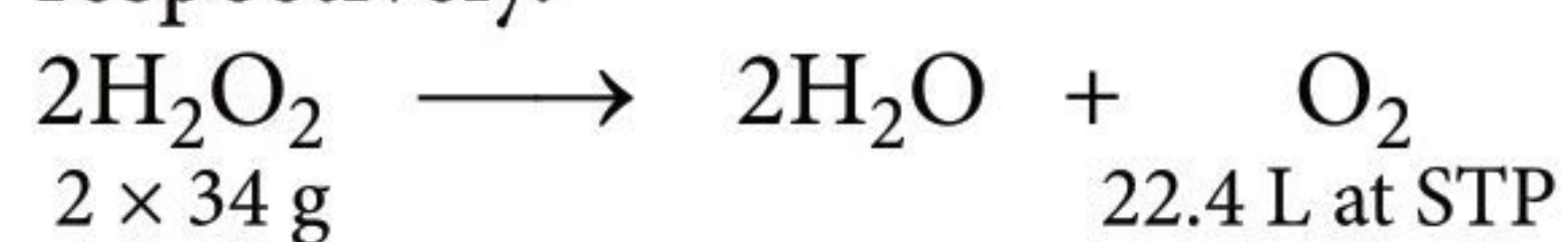


• **Reactions and uses**



Strength of Hydrogen Peroxide Solution

- **Volume strength of H_2O_2** : Volume strength of H_2O_2 means the volume of O_2 released by decomposition of 1 volume H_2O_2 . For example, H_2O_2 of x volume strength means 1 mL or 1 L of H_2O_2 on decomposition gives x mL or x L of oxygen respectively.



i.e., 22.4 L of oxygen is released from 68 g H_2O_2 , then x L of oxygen will be released from

$$= \frac{68}{22.4} \times x = \frac{17x}{5.6} \text{ g of } \text{H}_2\text{O}_2$$

$$\text{Strength} = \frac{17x}{5.6} \text{ g/L}$$

• $\text{Normality} = \frac{\text{Strength}}{\text{Equivalent weight}} = \frac{17x}{5.6} \times \frac{1}{17} = \frac{x}{5.6}$

\therefore Normality of H_2O_2 solution

$$= \frac{\text{Volume strength of } \text{H}_2\text{O}_2}{5.6}$$

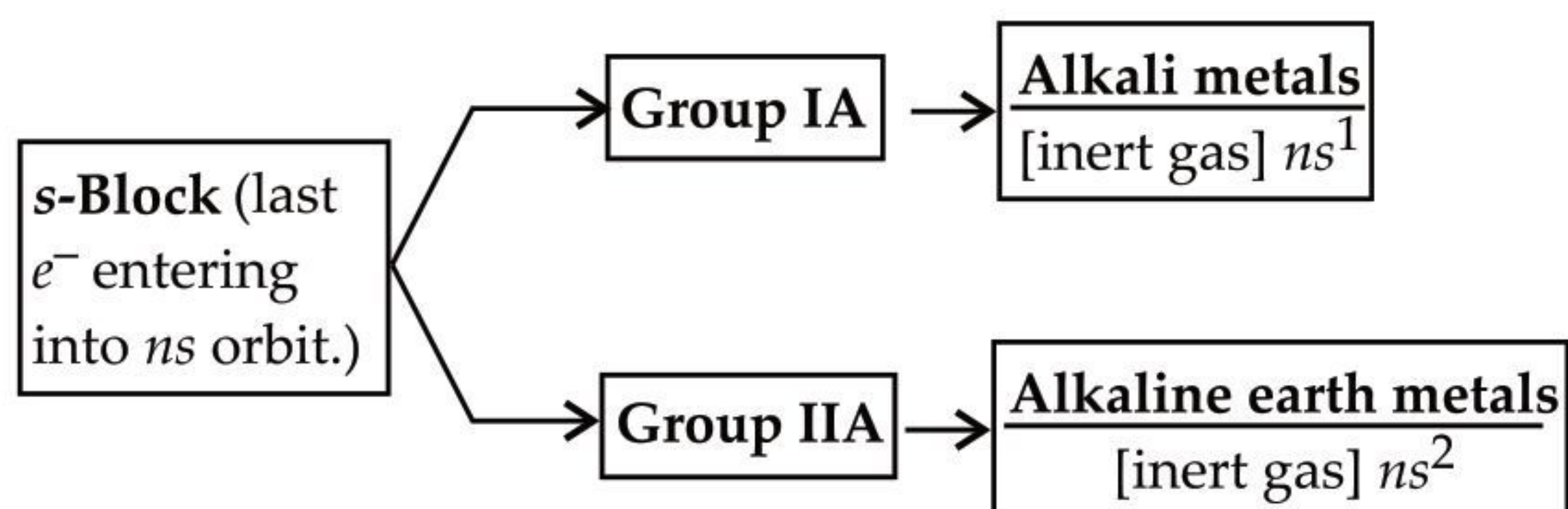
• $\text{Molarity} = \frac{\text{Normality}}{2} = \frac{x}{11.2}$ (Valency factor = 2)

\therefore Molarity of H_2O_2 solution

$$= \frac{\text{Volume strength of } \text{H}_2\text{O}_2}{11.2}$$

The s-Block Elements

The s-block elements are those in which the last electron enters the outermost s-orbital. Two groups (1 and 2) belongs to the s-block of periodic table.



GROUP 1 ELEMENTS : ALKALI METALS

Property	Li	Na	K	Rb	Cs	Fr
At. no. (Z)	3	11	19	37	55	87
Electronic configuration	[He] 2s ¹	[Ne] 3s ¹	[Ar] 4s ¹	[Kr] 5s ¹	[Xe] 6s ¹	[Rn] 7s ¹

Physical Properties

Physical state : Alkali metals are silvery white, soft and light metals. They have only one valence electron, so the metallic bond is not so strong which makes them soft metals.

Hydration of ions : Degree of hydration of alkali metal ions decreases in the order : $\text{Li}^+ > \text{Na}^+ > \text{K}^+ > \text{Rb}^+ > \text{Cs}^+$.

Conductivity : Increases down the group due to the presence of loosely held valence electron which is free to move throughout the metal structure.

Electropositive or metallic character : Alkali metals are strongly electropositive because of their low ionisation energies.

Oxidation state : All the alkali metals exhibit an oxidation state of +1.

Density : Increase from Li to Cs. However, potassium is lighter than sodium (anomaly) due to an unusual increase in atomic size of potassium.

Melting and boiling points : Due to weak intermetallic bonding, alkali metals have very low m.pt. and b.pt.

Flame colouration : All the alkali metals impart a characteristic colouration to the flame.

Li	Na	K	Rb	Cs
Crimson red	Golden yellow	Pale violet	Red violet	Blue

Gradation in Properties

Atomic radii	<div>Increases</div> <div>↓</div>	Li Na K Rb Cs	<div>Increases</div> <div>↑</div>	M.pt. and b.pt.
Atomic volume				Hardness
Density				Ionisation enthalpy
Reducing power				Heat of atomization
Electropositivity				Hydration enthalpy
Large anion stabilisation				Electronegativity

Diagonal relationship between lithium and magnesium

- Lithium shows diagonal relationship with magnesium since they have the same charge/size ratio *i.e.* polarising power.

ANOMALOUS BEHAVIOUR OF Li

All alkali metals	Li
Do not react directly with N ₂ or C.	Forms Li ₃ N or Li ₂ C ₂
Form amide (MNH ₂) with ammonia.	Forms Li ₂ NH
Nitrates are thermally stable.	LiNO ₃ is not Stable
Carbonates are thermally stable.	Li ₂ CO ₃ $\xrightarrow{\Delta}$ Li ₂ O + CO ₂
Form double salts (alums) from their sulphates.	Forms Li ₂ SO ₄

- Li and Mg show close resemblance in the following :

Nitrides	Li and Mg both form nitrides. Other alkali metals do not. $6\text{Li} + \text{N}_2 \xrightarrow{\Delta} 2\text{Li}_3\text{N}$, $3\text{Mg} + \text{N}_2 \xrightarrow{\Delta} \text{Mg}_3\text{N}_2$
Carbonates	Like MgCO_3 , Li_2CO_3 is decomposed by heat (the other alkali carbonates are thermally stable). $\text{MgCO}_3 \xrightarrow{\Delta} \text{MgO} + \text{CO}_2$, $\text{Li}_2\text{CO}_3 \xrightarrow{\Delta} \text{Li}_2\text{O} + \text{CO}_2$
Nitrates	LiNO_3 decomposes to give Li_2O like $\text{Mg}(\text{NO}_3)_2$, but other alkali metal nitrates give nitrite. $\text{Mg}(\text{NO}_3)_2 \xrightarrow{\Delta} \text{MgO} + 2\text{NO}_2 + 1/2\text{O}_2$; $2\text{LiNO}_3 \xrightarrow{\Delta} \text{Li}_2\text{O} + 2\text{NO}_2 + 1/2\text{O}_2$
Oxides	Both give their normal oxides (Li_2O , MgO) when they burn in oxygen.
Hydration	Both Li^+ and Mg^{2+} are heavily hydrated.

SOME IMPORTANT COMPOUNDS

Compound	Preparation	Properties	
		Physical	Chemical
Sodium hydroxide or caustic soda (NaOH)	Electrolytic process in mercury cathode cell $2\text{NaCl}_{(aq)} + 2\text{H}_2\text{O}_{(l)} \longrightarrow$ $\underbrace{\text{Cl}_{2(g)}}_{\text{At anode}} + \underbrace{\text{H}_{2(g)} + 2\text{NaOH}_{(aq)}}_{\text{At cathode}}$	NaOH is deliquescent, white crystalline solid. NaOH dissolves readily in water to yield highly alkaline solution which is corrosive, soapy in touch and bitter in taste.	$\text{Na}_2\text{CO}_3 \xleftarrow{\text{CO}_2} \text{HCOONa} \xleftarrow{\text{CO}} \text{Na}_2\text{SO}_3 \xleftarrow{\text{SO}_2} \text{Na}_2\text{S}_2\text{O}_3 \xleftarrow{\text{S}, \Delta} \text{NaH}_2\text{PO}_2 \xleftarrow{\text{P}_4} \text{NaH}_2\text{PO}_2 \xleftarrow{+\text{PH}_3} \text{NaMO}_2 \xleftarrow{M(M=\text{B}, \text{Al})} \text{NaOH}$ $\text{NaX} \xleftarrow{+\text{H}_2\text{O}} \text{NaXO}_3 \xleftarrow{+\text{H}_2\text{O}} \text{NH}_3 \uparrow \xleftarrow{\text{NH}_4\text{Cl}} \text{NaCl} \xleftarrow{+\text{H}_2\text{O}}$ $\text{X}_2 \text{ (Cold)} \rightarrow \text{NaX} + \text{NaXO} + \text{H}_2\text{O}$ $\text{Zn or ZnO}_2 \rightarrow \text{Na}_2\text{ZnO}_2$ $\text{SiO}_2 \rightarrow \text{Na}_2\text{SiO}_3$ $\text{Al}_2\text{O}_3 \text{ or Al(OH)}_3 \rightarrow \text{NaAlO}_2$ $\text{Sn} \rightarrow \text{Na}_2\text{SnO}_3$ $\text{ZnSO}_4 \rightarrow \text{Zn(OH)}_2 \xrightarrow{\downarrow \text{NaOH}} \text{Na}_2\text{ZnO}_2$ $\text{FeCl}_3 \rightarrow \text{Fe(OH)}_3 \downarrow + \text{NaCl}$
Sodium carbonate or washing soda ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$)	Sodium carbonate is manufactured by Solvay process. Sodium bicarbonate being sparingly soluble, crystallises out. This is finally calcined to form sodium carbonate. $\text{Na}^+ + \text{Cl}^- + \text{NH}_4^+ + \text{OH}^- + \text{CO}_2 \longrightarrow \text{Na}^+ + \text{HCO}_3^- + \text{NH}_4^+ + \text{Cl}^-$ $\text{Na}^+ + \text{HCO}_3^- \longrightarrow \text{NaHCO}_3$ (as precipitate) $2\text{NaHCO}_3 \xrightarrow{\Delta} \text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O}$	Sodium carbonate is a white crystalline solid which readily dissolves in water. Its solubility decreases with increase of temperature.	$2\text{NaHCO}_3 \xleftarrow{\text{CO}_2} \text{Na}_2\text{SiO}_3 \xleftarrow{\text{SiO}_2} \text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ $\text{CaCO}_3 \xleftarrow{\text{Ca(OH)}_2} \text{Na}_2\text{CO}_3 \xleftarrow{\Delta} \text{Na}_2\text{CO}_3 + 10\text{H}_2\text{O}$ $\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2\text{CO}_3$ $\text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$ $\text{SO}_2 \rightarrow \text{Na}_2\text{SO}_3 + \text{CO}_2$ $\text{H}_2\text{O, S} \rightarrow \text{Na}_2\text{S}_2\text{O}_3$
Sodium hydrogen carbonate or baking soda (NaHCO_3)	Obtained as an intermediate product in Solvay process. $\text{NaCl} + \text{NH}_3 + \text{CO}_2 + \text{H}_2\text{O} \longrightarrow \text{NaHCO}_3 + \text{NH}_4\text{Cl}$ It can also be prepared by passing CO_2 through solution of sodium carbonate. $\text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O} \longrightarrow 2\text{NaHCO}_3$	It is a white crystalline powder and less soluble than sodium carbonate.	NaHCO_3 on heating decomposes to produce bubbles of CO_2 which make the cakes and pastries fluffy. $2\text{NaHCO}_3 \xrightarrow[100^\circ\text{C}]{\Delta} \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$ It is amphoteric <i>i.e.</i> , it can act as H^+ donor as well as H^+ acceptor. $\text{HCO}_3^- + \text{H}^+ \rightleftharpoons \text{H}_2\text{CO}_3$; $\text{HCO}_3^- \rightleftharpoons \text{H}^+ + \text{CO}_3^{2-}$

GROUP 2 ELEMENTS : ALKALINE EARTH METALS

Property	Be	Mg	Ca	Sr	Ba	Ra
At. no. (Z)	4	12	20	38	56	88
Electronic configuration	[He] $2s^2$	[Ne] $3s^2$	[Ar] $4s^2$	[Kr] $5s^2$	[Xe] $6s^2$	[Rn] $7s^2$

Physical Properties

Atomic and ionic radii : Smaller than corresponding alkali metals and increases down the group.

Oxidation number and valency : All form divalent cations and exhibit +2 oxidation state.

Conductance : Good conductors of heat and electricity.

Melting and boiling points : Higher than alkali metals and do not show any regular trend because of different crystal structures adopted by different metals.

Density : Denser, heavier and harder than alkali metals and density decreases from Be to Ca and then increases.

**Group 2
Elements
(ns^2)**

Physical state : All are silvery white when freshly cut, light, malleable and soft but harder than alkali metals.

Ionisation enthalpy : Higher than corresponding alkali metals and decreases down the group.

Electropositive or metallic character : Less electropositive or metallic than alkali metals.

Electronegativity : Higher than corresponding alkali metals and decreases down the group.

Gradation in Properties

Atomic radii		↑	Ionization enthalpy
Electropositivity			Electronegativity
Reducing power			Hydration enthalpy
Stability of carbonates, hydroxides and sulphates	Increases	Be Mg Ca Sr Ba	Solubility of carbonates and bicarbonates
Solubility and basic strength of oxides and hydroxides	↓		Solubility of halides

Anomalous Behaviour of Be

All alkaline earth metals	Be
Form ionic non-volatile nitrides.	Be_3N_2 is covalent and volatile.
Form ionic carbonates.	BeCO_3 is unstable.
Form basic oxides.	BeO is amphoteric.

DIAGONAL RELATIONSHIP BETWEEN Be AND Al

- The similarity between Be and Al arises due to their same electronegativity, polarising power and the charge / radius ratio of their ions.

- Be^{2+} and Al^{3+} favour covalent bonding due to same charge to radius ratio.
- Both become passive on treating with conc. HNO_3 .
- Both Be_2C and Al_4C_3 on hydrolysis give methane.
 $\text{Be}_2\text{C} + 4\text{H}_2\text{O} \rightarrow 2\text{Be}(\text{OH})_2 + \text{CH}_4$
 $\text{Al}_4\text{C}_3 + 12\text{H}_2\text{O} \rightarrow 4\text{Al}(\text{OH})_3 + 3\text{CH}_4$
- $\text{Be}(\text{OH})_2$ dissolves in excess of alkali to give a beryllate ion $[\text{Be}(\text{OH})_4]^{2-}$, $\text{Al}(\text{OH})_3$ gives aluminate ion $[\text{Al}(\text{OH})_4]^-$.
- Both Be and Al form complexes like $[\text{BeF}_4]^{2-}$ and $[\text{AlF}_6]^{3-}$.
- Both BeO and Al_2O_3 or $\text{Be}(\text{OH})_2$ and $\text{Al}(\text{OH})_3$ are amphoteric in nature.

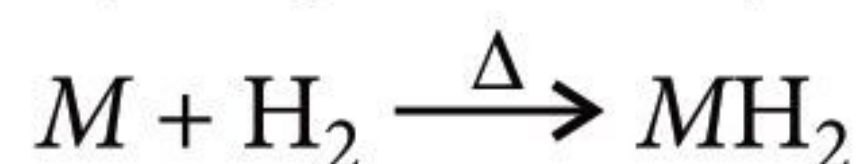
Quotable Quote

"Life is not easy for any of us. But what of that? We must have perseverance and above all confidence in ourselves. We must believe that we are gifted for something and that this thing must be attained."

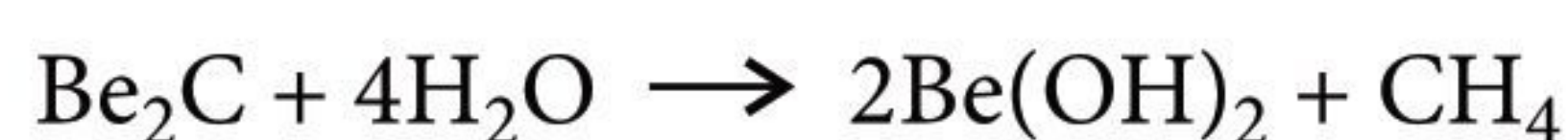
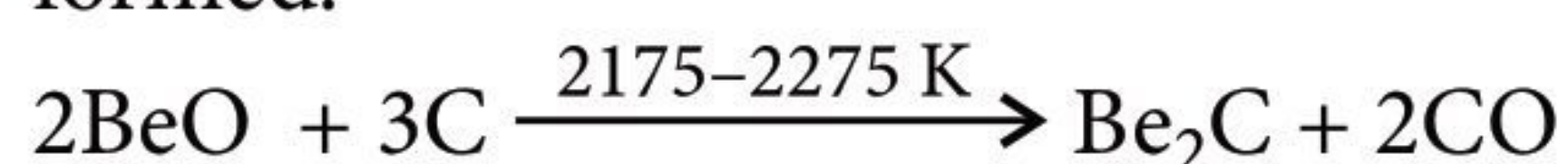
Marie Curie

CHEMICAL PROPERTIES

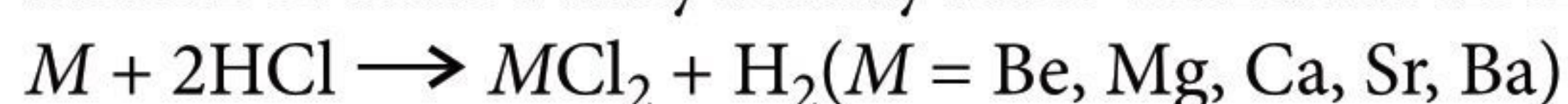
- **Reaction with hydrogen (formation of hydrides) :** All the alkaline earth metals except Be combine with hydrogen directly on heating to form metal hydrides of formula, MH_2 .



- **Reaction with halogens :** They react with halogens at elevated temperature to form the halides of the type MX_2 .
- **Reaction with ammonia :** Like alkali metals, the alkaline earth metals dissolve in liquid ammonia to give deep blue-black solution from which ammoniates $[M(NH_3)_6]^{2+}$ can be recovered.
- **Reaction with carbon :** When BeO is heated with carbon at 2175 – 2275 K a brick red coloured carbide is formed.



- **Action of acids :** They readily react with acids liberating hydrogen.



SOME IMPORTANT COMPOUNDS

Compounds

Calcium oxide

- Obtained by decomposing lime stone ($CaCO_3$).
- Use for manufacturing cement and other chemicals.
- Also called quick lime.

Calcium carbonate

- Also called lime stone, $CaCO_3$.
- Used for manufacturing CaO, cement, glass, slaked lime etc.

Plaster of Paris

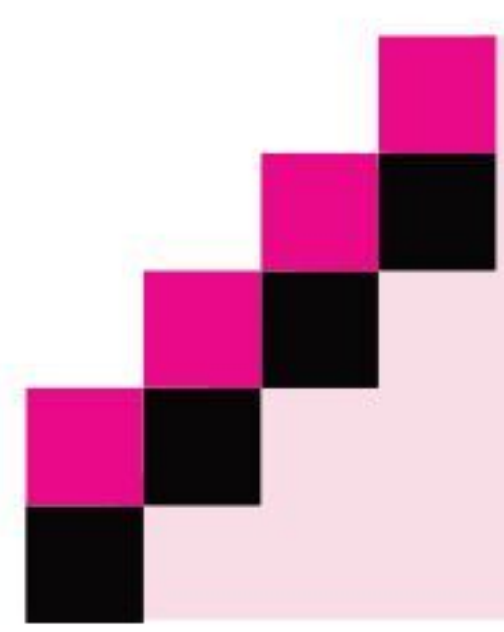
- It is chemically calcium sulphate hemihydrate ($CaSO_4 \cdot 1/2 H_2O$)
- Prepared by heating gypsum ($CaSO_4 \cdot 2H_2O$) at 393 K. At high temperature dead burnt plaster ($CaSO_4$) is obtained.
- When mixed with water it converts into a hard mass gypsum. So, it is used for plastering bones, making casts of statues and busts.

Calcium hydroxide

- Also called slaked lime.
- $CaO + H_2O \longrightarrow Ca(OH)_2$
- Turns milky when CO_2 is passed but in excess of CO_2 milkiness disappears.
- Used to prepare mortar and bleaching powder.

Cement

- It is mixture of silicate and aluminate of Ca with small amount of gypsum.
- Raw materials used : limestone, clay, gypsum.
- Gypsum is added to slow down the process of setting.



WRAP it up!

MCQs Type

- What product is obtained when CO_2 gas is passed through slaked lime?
(a) $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$ (b) CaCl_2
(c) CaO (d) CaCO_3
- Which of the following statements is not true about alkali metals?
(a) Alkali metals do not occur free in nature.
(b) Alkali metals are good oxidising agents.
(c) Alkali metal salts impart colour to the flame.
(d) Alkali metal salts are generally ionic.
- Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Lithium salts are hydrated.
Reason (R) : Lithium has higher polarising power than other alkali metal group members.
In the light of the above statements, choose the most appropriate answer from the options given below.
(a) (A) is not correct but (R) is correct.
(b) (A) is correct but (R) is not correct.
(c) Both (A) and (R) are correct but (R) is not the correct explanation of (A).
(d) Both (A) and (R) are correct and (R) is the correct explanation of (A).
- Boiling point of heavy water is
(a) 101.4°C (b) 99°C
(c) 100°C (d) 110°C
- H_2O_2 can be obtained when following reacts with H_2SO_4 except with
(a) PbO_2 (b) BaO_2
(c) Na_2O_2 (d) SrO_2
- Which of the following statements is incorrect ?
(a) The viscosity of H_2O is lesser than that of D_2O .
(b) Reaction between H_2 and Cl_2 is much faster than D_2 and Cl_2 .
(c) D_2O freezes at lower temperature than H_2O .
(d) Bond dissociation energy for D_2 is greater than H_2 .
- Last molecule of H_2O is evolved from H_2O_2 by
(a) distillation under reduced pressure
(b) evaporation
(c) crystallisation
(d) electrolysis.
- The oxide that gives H_2O_2 most readily on treatment with H_2O is
(a) Na_2O_2 (b) $\text{BaO}_2 \cdot 8\text{H}_2\text{O}$
(c) SnO_2 (d) PbO_2
- The molecular formula of a commercial resin used for exchanging ions in water softening is $\text{C}_8\text{H}_7\text{SO}_3\text{Na}$ (Mol. wt. 206). What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin?
(a) $\frac{2}{309}$ (b) $\frac{1}{412}$
(c) $\frac{1}{103}$ (d) $\frac{1}{206}$
- Which one of the following pairs of substances will not produce hydrogen when reacted together?
(a) Copper and conc. nitric acid
(b) Ethanol and metallic sodium
(c) Magnesium and steam
(d) Phenol and metallic sodium
- The structures of beryllium chloride in solid state and vapour phase are
(a) chain in both
(b) chain and dimer, respectively
(c) linear in both
(d) dimer and linear, respectively.
- Which one of the following alkaline earth metal sulphates has its hydration enthalpy greater than its lattice enthalpy?
(a) BaSO_4 (b) SrSO_4
(c) CaSO_4 (d) BeSO_4
- Baeyer's reagent is used in the laboratory for
(a) detection of benzene
(b) detection of glucose
(c) detection of double bond
(d) reduction process.

14. Enzymes that utilize ATP in phosphate transfer require an alkaline earth metal (M) as the cofactor. M is
 (a) Sr (b) Be
 (c) Mg (d) Ca (NEET 2019)
15. Which of the following statements about hydrogen is incorrect?
 (a) Hydronium ion, H_3O^+ exists in solution.
 (b) Dihydrogen does not act as a reducing agent.
 (c) Hydrogen has three isotopes of which protium is the most common.
 (d) Hydrogen never acts as cation in ionic salts.
16. The method used to remove temporary hardness of water is
 (a) synthetic resins method
 (b) Calgon's method
 (c) Clark's method
 (d) ion-exchange method. (NEET 2019)
17. Select correct statement(s).
 (a) CaCO_3 is more soluble in a solution of CO_2 than in H_2O .
 (b) Na_2CO_3 is converted to Na_2O and CO_2 on heating.
 (c) Li_2CO_3 is thermally stable.
 (d) Presence of CaCl_2 or CaSO_4 in water causes temporary hardness.
18. In which of the following reactions H_2O acts as a Bronsted acid?
 (a) $\text{H}_2\text{O}_{(l)} + \text{NH}_{3(aq)} \rightleftharpoons \text{OH}^-_{(aq)} + \text{NH}_4^+_{(aq)}$
 (b) $\text{H}_2\text{O}_{(l)} + \text{H}_2\text{S}_{(aq)} \rightleftharpoons \text{H}_3\text{O}^+_{(aq)} + \text{HS}^-_{(aq)}$
 (c) $\text{HCl} + \text{H}_2\text{O}_{(l)} \rightleftharpoons \text{H}_3\text{O}^+_{(aq)} + \text{Cl}^-$
 (d) $\text{H}^+_{(aq)} + \text{OH}^-_{(aq)} \rightleftharpoons \text{H}_2\text{O}_{(l)}$
19. Which of the following statements is not correct regarding preparation of NaOH ?
 (a) NaOH is prepared by electrolysis of sodium chloride in Castner-Kellner cell.
 (b) Sodium metal discharged at cathode combines with mercury to form sodium amalgam.
 (c) Chlorine is evolved at anode.
 (d) Amalgam is heated to separate Na and Hg .
20. Among the following alkaline earth metal halides one which is covalent and soluble in organic solvents is
 (a) beryllium chloride (b) calcium chloride
 (c) strontium chloride (d) magnesium chloride.
21. Which of the following explanations justifies for not placing hydrogen in either the group of alkali metals or halogens?
 (a) Hydrogen is much lighter than alkali metals or halogens.
 (b) Hydrogen atom does not contain any neutron.
 (c) The ionization energy of hydrogen is too high for group of alkali metals and too low for halogen group.
 (d) Hydrogen can form compounds with almost all other elements.
22. Hydrogen will not reduce
 (a) heated stannic oxide
 (b) heated ferric oxide
 (c) heated cupric oxide
 (d) heated aluminium oxide.
23. In comparison to the zeolite process for the removal of permanent hardness, the synthetic resins method is
 (a) less efficient as the resins cannot be regenerated
 (b) less efficient as it exchanges only anions
 (c) more efficient as it can exchange only cations
 (d) more efficient as it can exchange both cations as well as anions. (JEE Main 2020)
24. Hardness of water is due to which pair of ions?
 (a) Ca^{2+} and Mg^{2+} (b) Mg^{2+} and K^+
 (c) Ca^{2+} and K^+ (d) Ba^{2+} and Zn^{2+}
25. Deuteroammonia (ND_3) can be prepared
 (a) by fractionation of ordinary ammonia
 (b) by action of heavy water on magnesium nitride
 (c) by heating a solution of NH_4Cl in NaOD
 (d) none of the above.

NUMERICAL VALUE TYPE

26. 100 mL of tap water containing $\text{Ca}(\text{HCO}_3)_2$ was titrated with $N/50$ HCl with methyl orange as indicator. If 30 mL of HCl were required, the temporary hardness as parts of CaCO_3 per 10^6 parts of water is _____.
27. There are three samples of hydrogen peroxide labelled 10 vol., 15 vol. and 20 vol. Half litre of each was mixed. Calculate volume strength of the new solution.
28. X is used for immobilising the affected part of organ where there is a sprain. X is obtained on heating gypsum at 393 K. The number of expelled

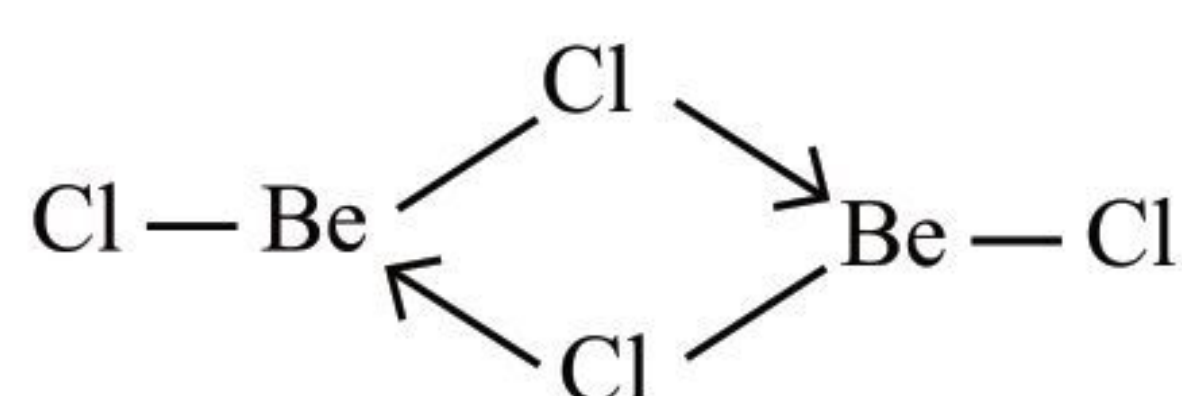
water molecules when X is obtained by heating 2 molecules of gypsum is _____.

29. The label on a bottle of H_2O_2 solution reads as '10 volume'. The concentration of H_2O_2 in percentage by volume, rounded off to nearest integer, is _____.
30. A 20.0 mL solution containing 0.2 g impure H_2O_2 reacts completely with 0.316 g of KMnO_4 in acid solution. The purity of H_2O_2 (in %) is _____. (mol. wt. of $\text{H}_2\text{O}_2 = 34$; mol. wt. of $\text{KMnO}_4 = 158$)
(JEE Main 2020)

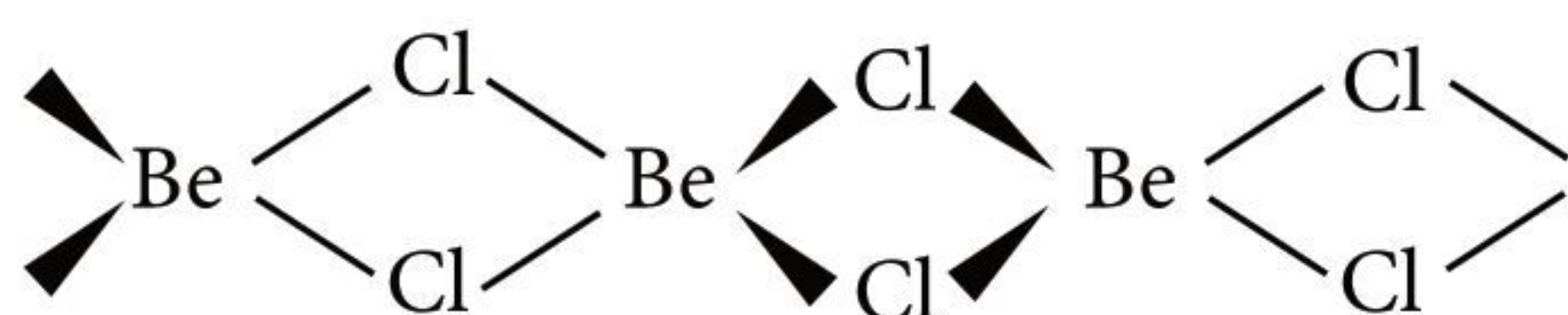
SOLUTIONS

- (d): $\text{Ca}(\text{OH})_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 + \text{H}_2\text{O}$
- (b): Alkali metals are good reducing agents.
- (c): Li^+ has maximum degree of hydration due to its small size and for this reason lithium salts are mostly hydrated.
- (a): Boiling point of heavy water is 101.4°C .
- (a): PbO_2 does not have peroxy linkage.
- (c)
- (c): Last trace of water is removed from H_2O_2 by crystallisation.
- (a): $\text{Na}_2\text{O}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2\text{O}_2$
- (b): $2\text{C}_8\text{H}_7\text{SO}_3^- \text{Na}^+ + \text{Ca}^{2+} \rightarrow (\text{C}_8\text{H}_7\text{SO}_3)_2\text{Ca}^{2+} + 2\text{Na}^+$
 $\frac{2 \text{ mol}}{(2 \times 206 = 412 \text{ g})} \quad \frac{1 \text{ mol}}{1 \text{ mol}}$
 1 mol of $\text{Ca}^{2+} \equiv 412 \text{ g}$ of resin
 Maximum uptake of Ca^{2+} ions by the resin

$$= \frac{1 \text{ mol}}{412 \text{ g}} = \frac{1}{412} \text{ mol/g}$$
- (a): $\text{Cu} + 4\text{HNO}_3(\text{conc.}) \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$
 $\text{C}_2\text{H}_5\text{OH} + \text{Na} \rightarrow \text{C}_2\text{H}_5\text{O}^- \text{Na}^+ + 1/2\text{H}_2\uparrow$
 $\text{Mg} + 2\text{H}_2\text{O}_{(\text{steam})} \rightarrow \text{Mg}(\text{OH})_2 + \text{H}_2\uparrow$
 $\text{C}_6\text{H}_5\text{OH} + \text{Na} \rightarrow \text{C}_6\text{H}_5\text{O}^- \text{Na}^+ + 1/2\text{H}_2\uparrow$
- (b): In vapour phase BeCl_2 is found in dimer form.



While in solid state it is found as a polymer (chain structure).

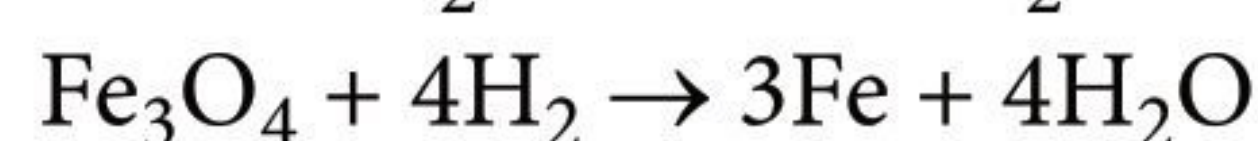
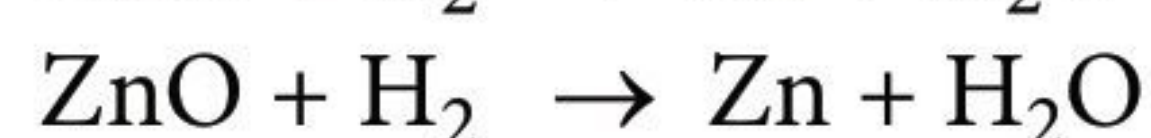
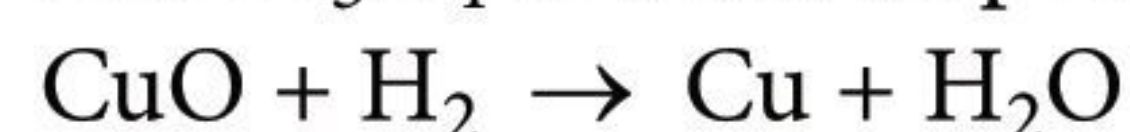


12. (d): Be^{2+} being smaller in size has maximum hydration enthalpy which exceeds its lattice enthalpy.

13. (c)

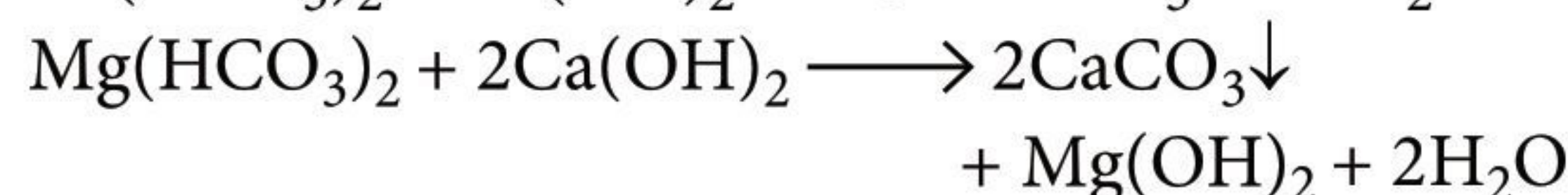
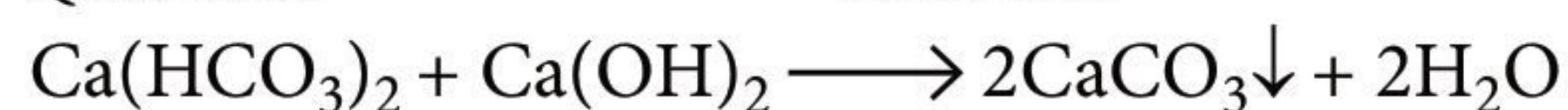
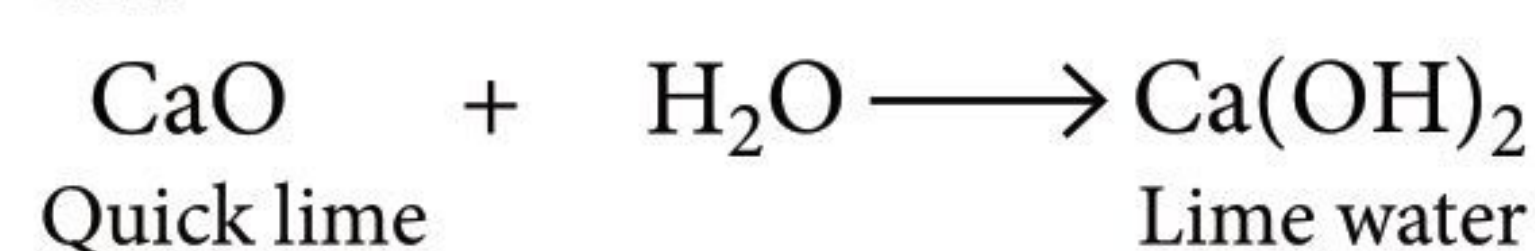
14. (c): All enzymes that utilise ATP in phosphate transfer require magnesium as the cofactor.

15. (b): Dihydrogen acts as a powerful reducing agent and reduces metal oxides such as CuO , ZnO , PbO and Fe_3O_4 to their respective metals.



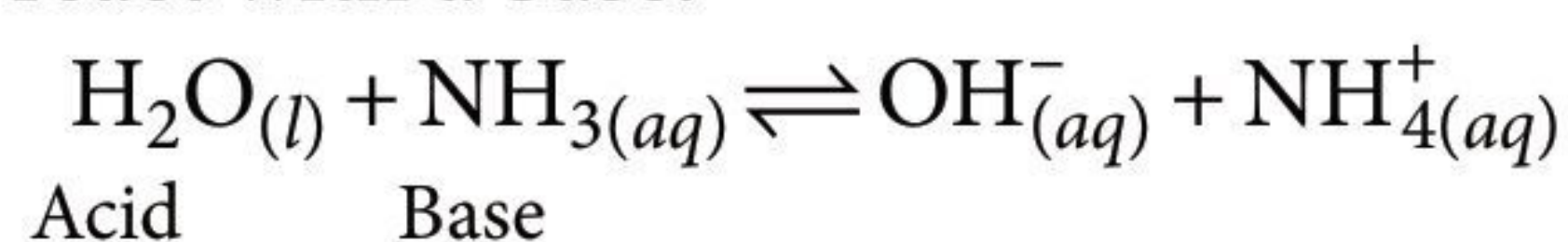
Hydrogen has three isotopes of which protium is the most common and tritium is radioactive.

16. (c): Clark's method is used to remove temporary hardness of water. In this method quick lime is added. The bicarbonates present in temporary hard water react with lime to form insoluble calcium and magnesium carbonates which can be easily filtered off.



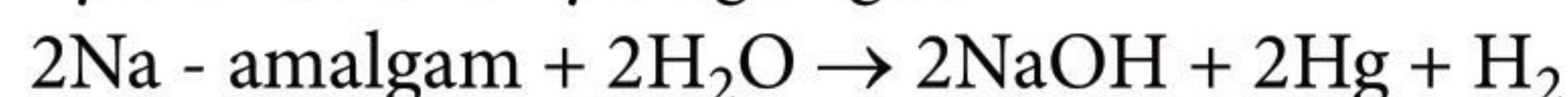
17. (a)

18. (a): H_2O acts as a Bronsted acid and gives a proton to react with a base.



In $\text{H}_2\text{O}_{(l)} + \text{H}_2\text{S}_{(aq)} \rightarrow \text{H}_3\text{O}^+_{(aq)} + \text{HS}^-_{(aq)}$, H_2O acts as a Bronsted base with H_2S .

19. (d): Amalgam is treated with water to give sodium hydroxide and hydrogen gas.



20. (a): Except for beryllium halides, all other halides of alkaline earth metals are ionic in nature. Beryllium halides are essentially covalent and soluble in organic solvents.

21. (c): Hydrogen has ionization energy value which is too high as compared to alkali metals and too low as compared to halogens and thus cannot be placed in any of these two groups.

22. (d): Al is more electropositive than hydrogen, therefore, its oxide will not be reduced by hydrogen.

23. (d)

24. (a) : Hardness of water is due to Ca^{2+} and Mg^{2+} ions.

25. (b) : $\text{Mg}_3\text{N}_2 + 6\text{D}_2\text{O} \rightarrow 3\text{Mg}(\text{OD})_2 + 2\text{ND}_3$

26. (300) : Milli eq. $\text{HCl} \equiv$ Milli eq. of $\text{Ca}(\text{HCO}_3)_2 \equiv$ Milli eq. of CaCO_3

$$\text{Mass of CaCO}_3 \text{ in 100 mL tap water} = \frac{E \times N \times V}{1000}$$

$$= \frac{50 \times 30}{50 \times 1000} = 0.03 \text{ g} \Rightarrow \text{Hardness} = 300 \text{ ppm}$$

27. (15) : Normality = $\frac{\text{Volume strength}}{5.6}$

$$N_1 = \frac{10}{5.6}, N_2 = \frac{15}{5.6}, N_3 = \frac{20}{5.6}$$

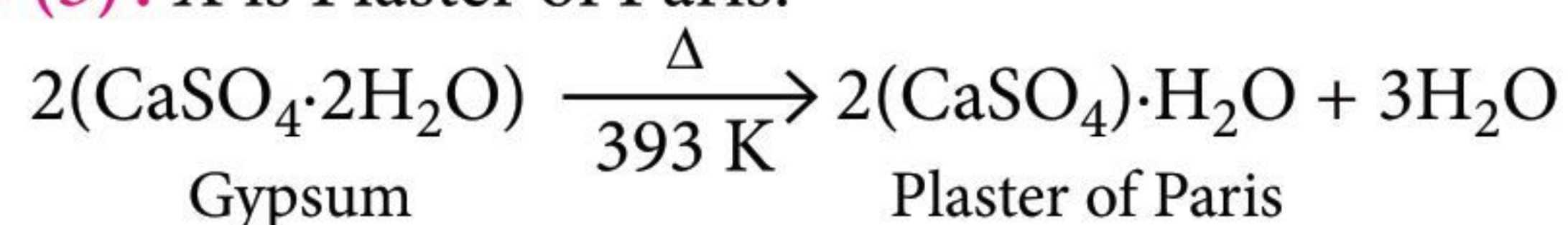
$$\text{New normality} = \frac{N_1V_1 + N_2V_2 + N_3V_3}{V_1 + V_2 + V_3}$$

$$N = \frac{\left(\frac{10}{5.6} \times 0.5\right) + \left(\frac{15}{5.6} \times 0.5\right) + \left(\frac{20}{5.6} \times 0.5\right)}{0.5 + 0.5 + 0.5}$$

$$N = 2.679$$

$$\text{New volume strength} = N \times 5.6 = 2.679 \times 5.6 = 15 \text{ vol}$$

28. (3) : X is Plaster of Paris.



\therefore 3 molecules of water are expelled.

29. (2) : 10 V of H_2O_2 means 1 V of H_2O_2 gives 10 V of O_2 gas.

$$\text{No. of moles of O}_2 = \frac{10 \text{ L}}{22.4 \text{ L/mol}} = 0.45 \text{ mol}$$

$$\text{No. of moles of H}_2\text{O}_2 = 0.90 \text{ mol}$$

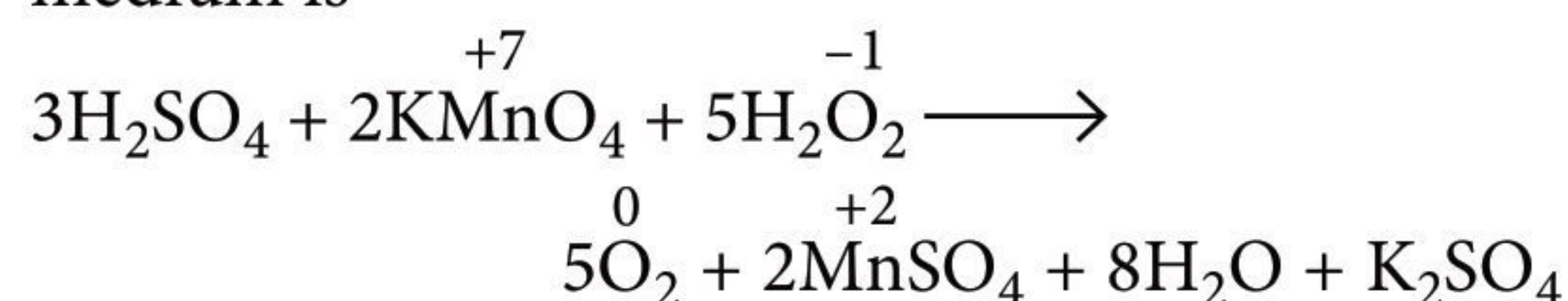
$$\text{Mass of H}_2\text{O}_2 = 34 \times 0.90 = 30.6 \text{ g}$$

$$\text{Density of H}_2\text{O}_2 = 1.44 \text{ g/mol}$$

$$\text{Volume of H}_2\text{O}_2 = \frac{30.6}{1.44} \text{ mL} = 21.25 \text{ mL} = 0.021 \text{ L}$$

$$\% \text{ Volume of H}_2\text{O}_2 = 0.021 \times 100 = 2.1\% \approx 2\%$$

30. (85) : Reaction of H_2O_2 with KMnO_4 in acidic medium is



Valency factor for $\text{H}_2\text{O}_2 = 2$

Valency factor for $\text{KMnO}_4 = 5$

$$\left[\frac{x}{34}\right] \times 2 = \frac{0.316}{158} \times 5$$

$$\Rightarrow x = \frac{0.316 \times 5 \times 34}{158 \times 2} = 0.17 \text{ g}$$

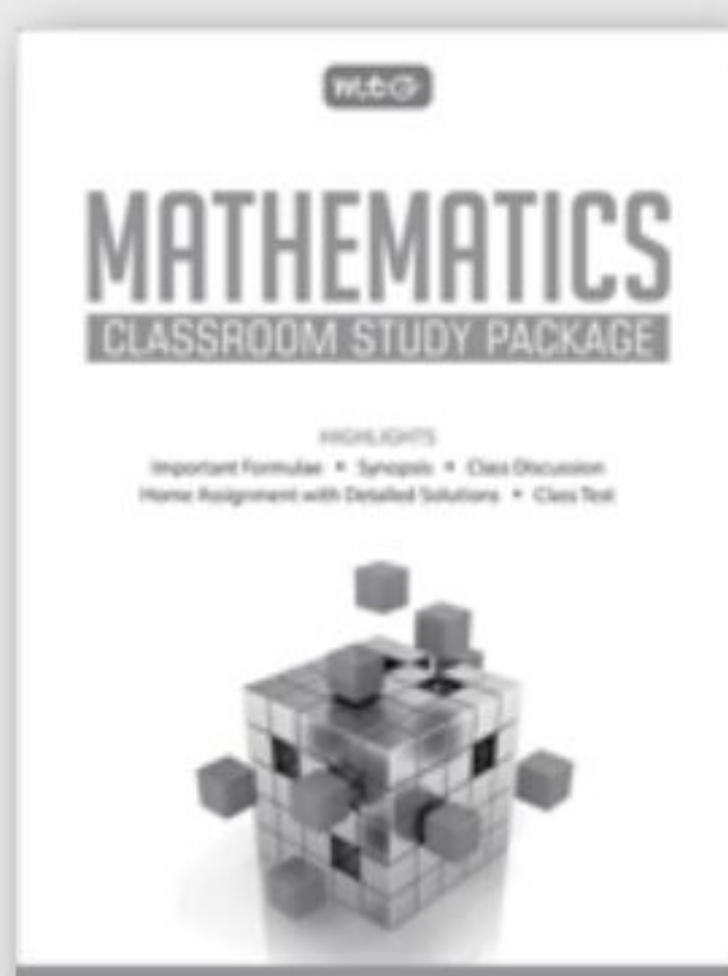
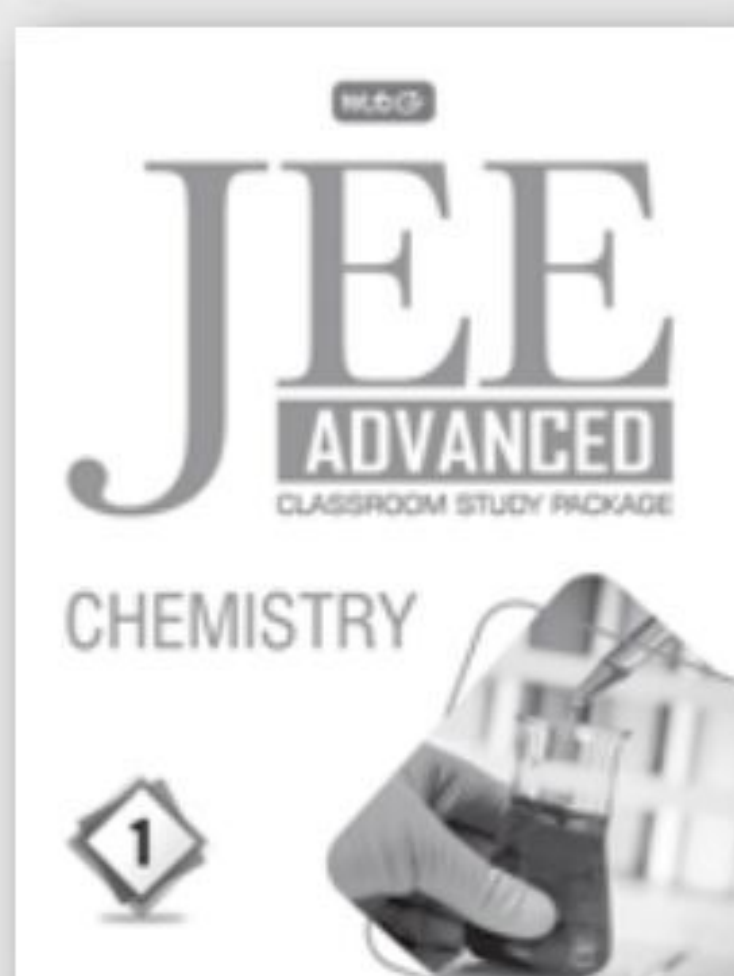
$$\% \text{ Purity} = \frac{\text{Weight of pure substance}}{\text{Weight of given sample}} \times 100$$

$$= \frac{0.17}{0.2} \times 100 = 85\%$$



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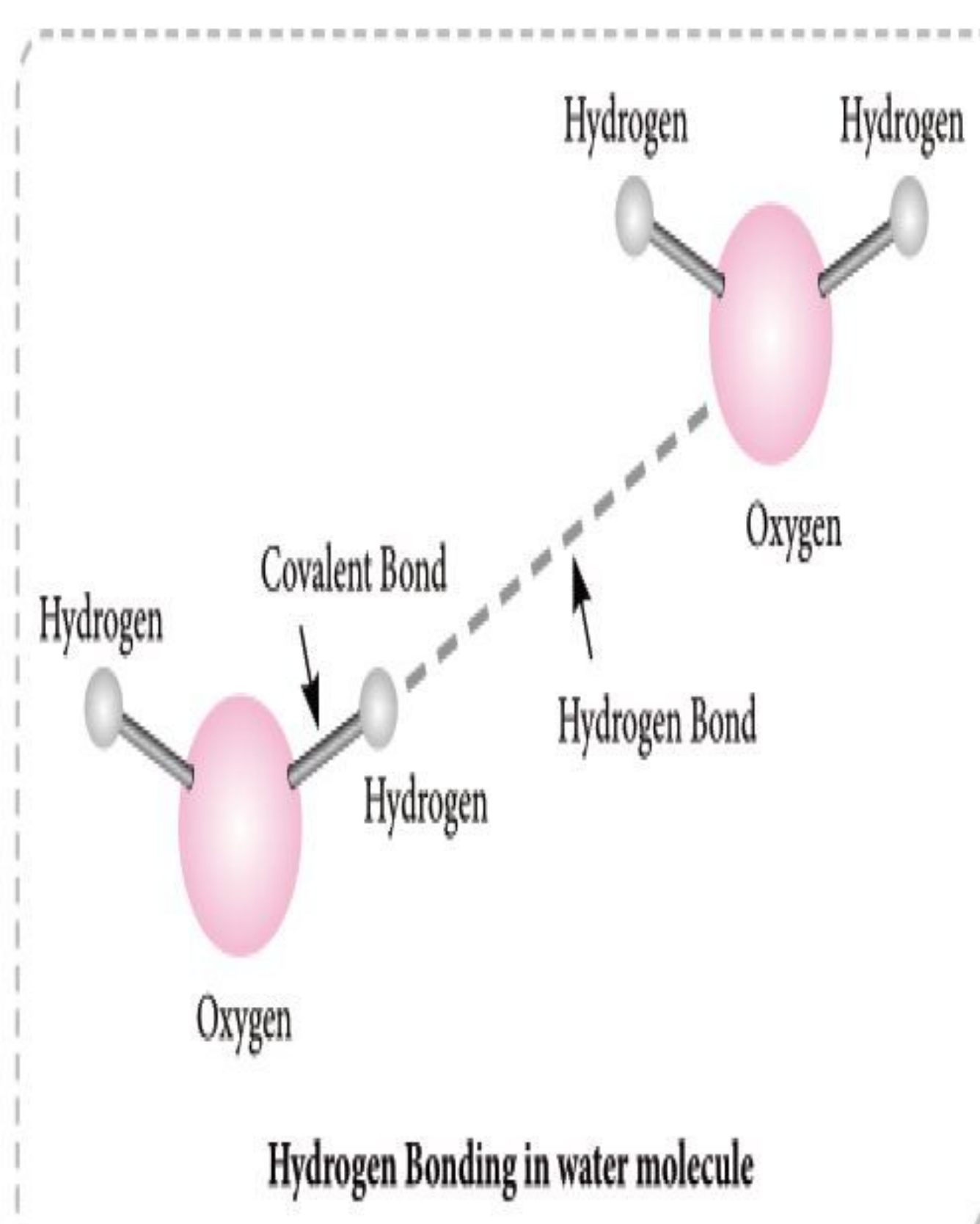
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CONCEPT MAP

CHEMICAL BONDING

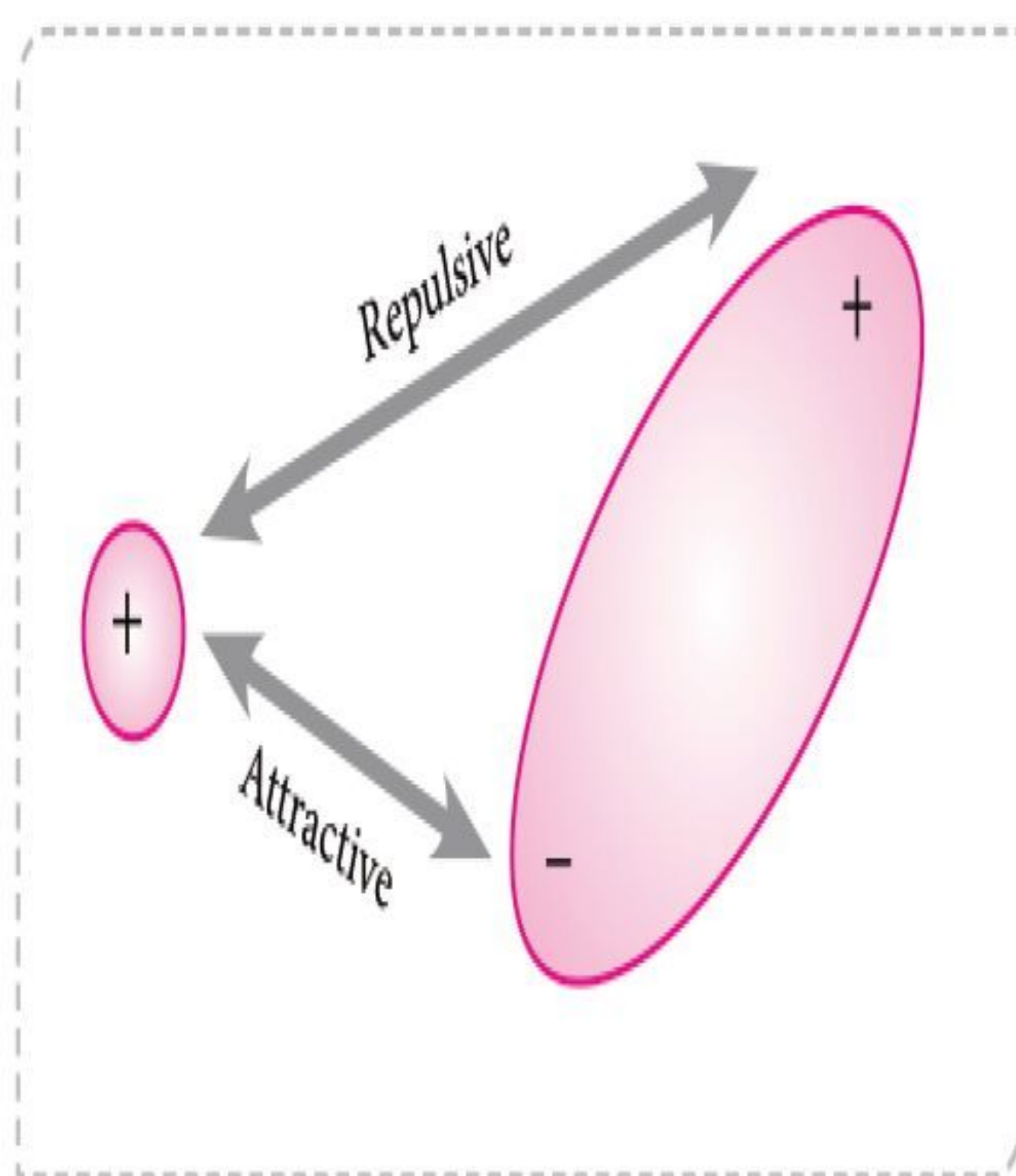


Hydrogen bonding occurs when :

- ♦ Hydrogen atom is attached to a highly electronegative atom such as F, O and N.
- ♦ The highly electronegative atom is small in size.
- ♦ The highly electronegative atom has unshared pair of electrons.

Electrostatic attraction between a hydrogen covalently bonded to a more electronegative atom and another electronegative atom bearing a lone pair of electrons.

Hydrogen Bond



Dipole Interactions

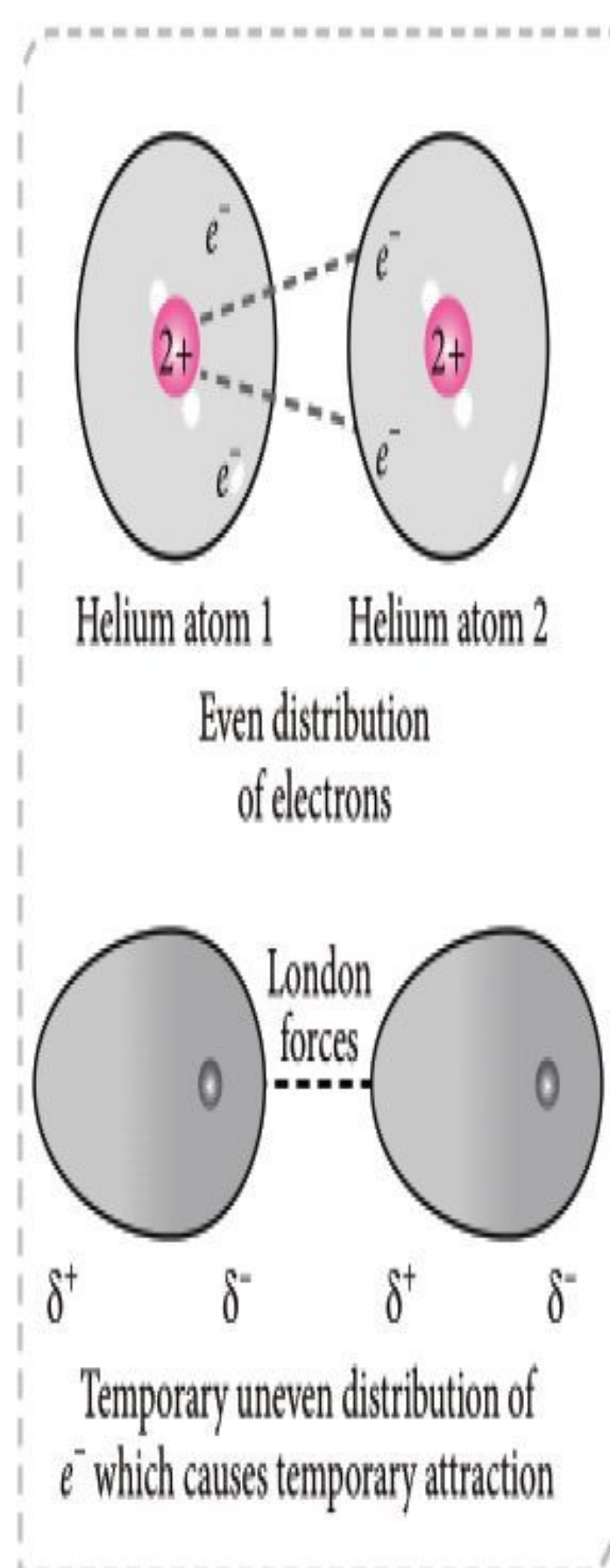
- ♦ It results when two dipolar molecules interact with each other through space.
- ♦ Polar molecules align so that the positive end of one molecule attract the negative end of another molecule.

van der Waals' Forces

There are weak electrostatic forces between uncharged molecules.

London Forces

- ♦ It is a temporary attractive force that results when an electron in two adjacent atom occupy positions that make atoms to form temporary dipole.
- ♦ It is also called induced dipole-induced dipole.
- ♦ This is the weakest intermolecular force.



CHEMICAL BONDS

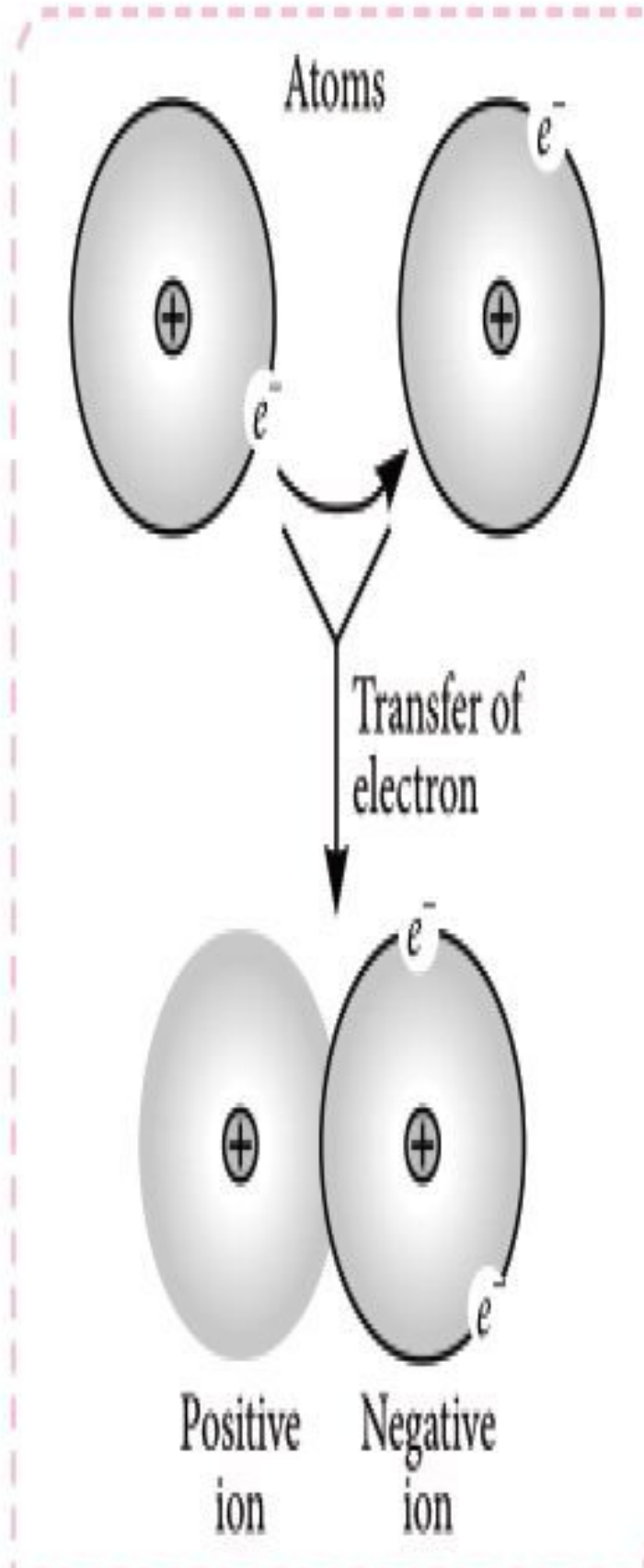
When a chemical bond is formed, the potential energy becomes minimum and the system gains stability.

Secondary Bonds

Secondary bonds are not bonds with valence electrons being shared or donated, they are usually formed when an uneven charge distribution occurs.

Ionic Bond

The electrostatic bond between two ions formed through the transfer of one or more electrons.

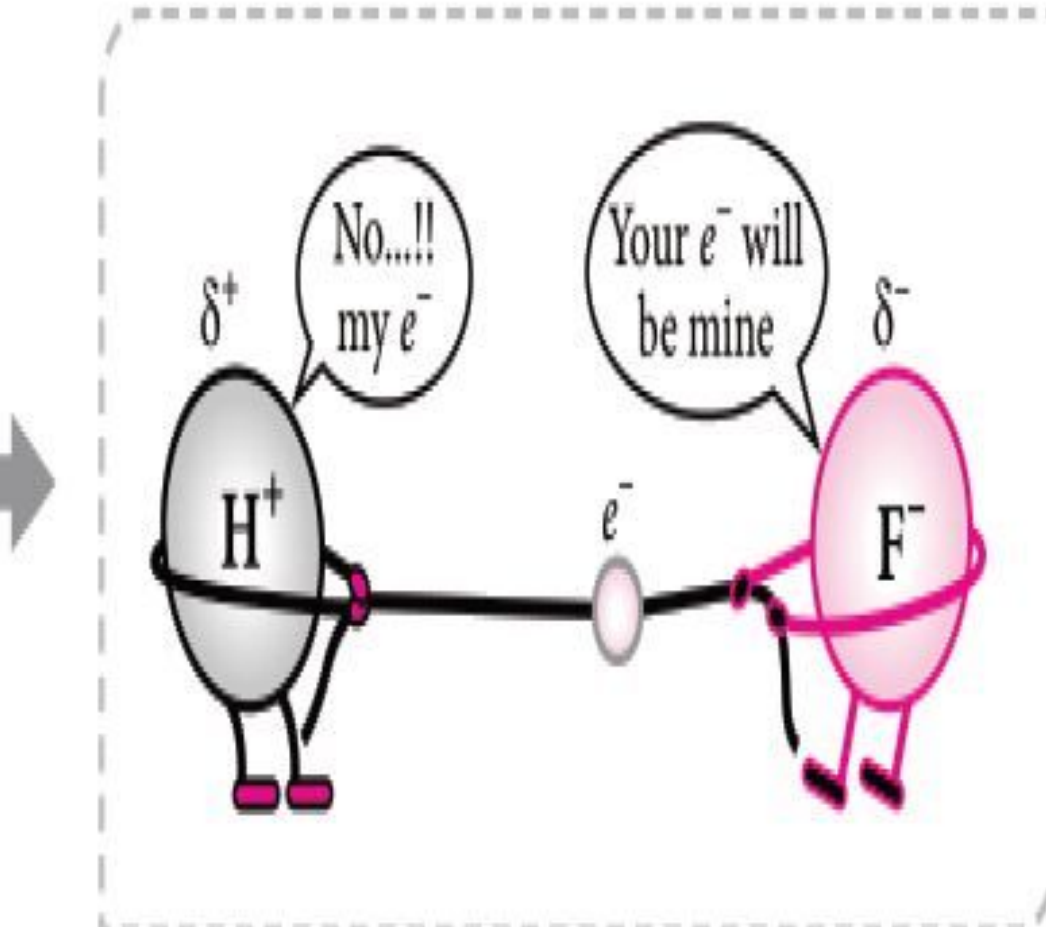


Factors favouring ionic bond formation :

- ♦ Low ionisation enthalpy of metal
- ♦ High electron gain enthalpy of non-metal
- ♦ High lattice enthalpy of the ionic compound
 - Higher charge on ions
 - Larger size of cation

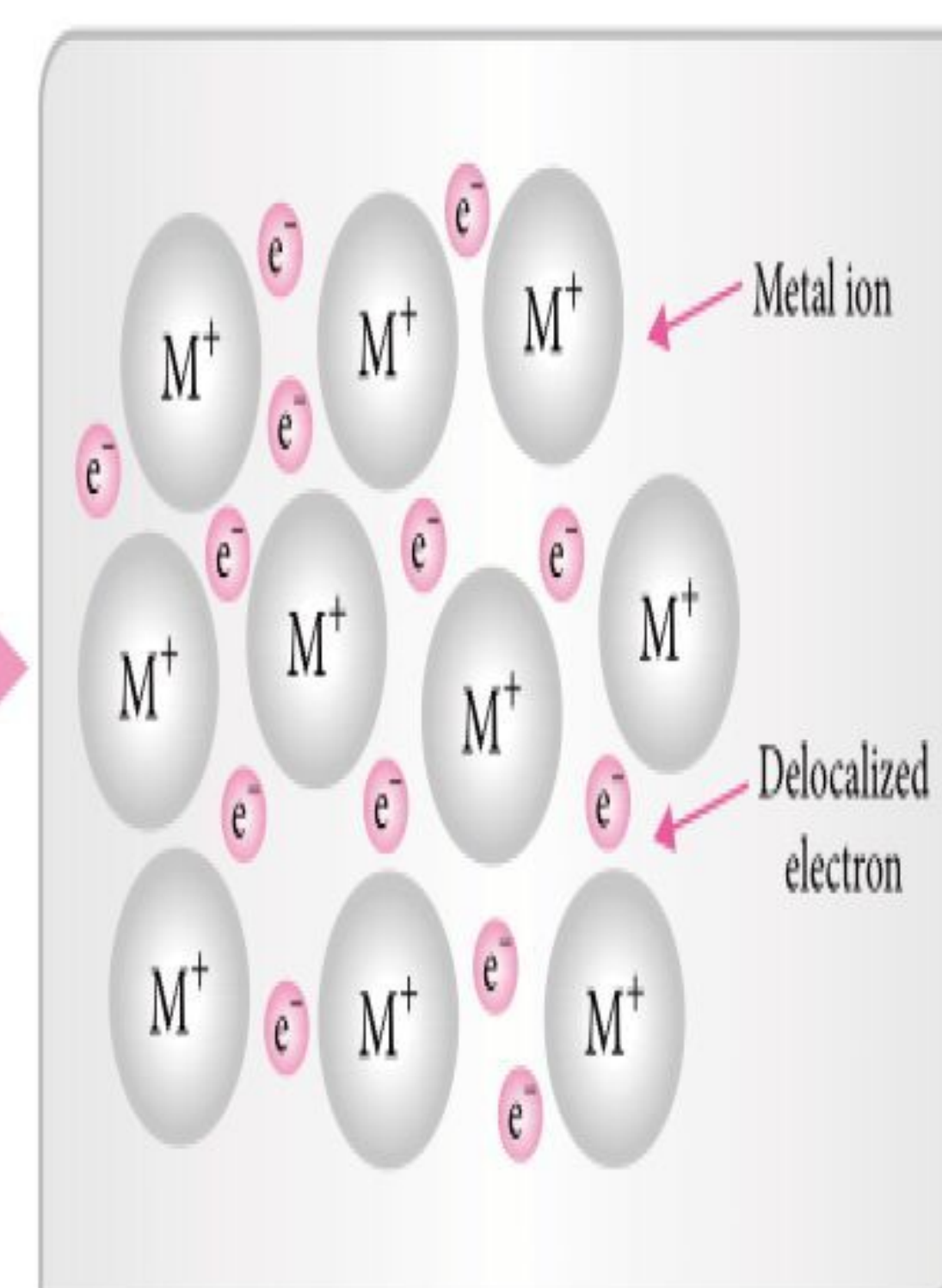
Factors favouring metallic bond formation :

- ♦ Low ionization enthalpy.
- ♦ Free movement of valence electrons.



Electrostatic attraction between sea of electrons and positive ions.

Metallic Bond



Primary Bonds

Primary bonds involve sharing or donating of electrons between atoms to form a more stable electronic configuration.

Coordinate Bond

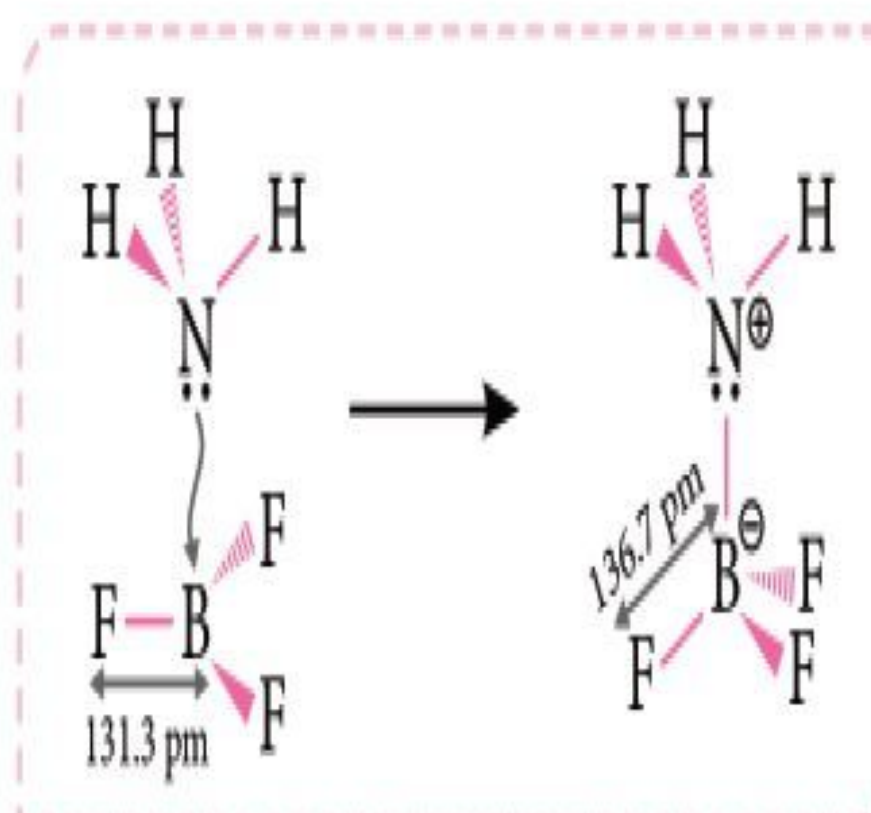
In this type of bond sharing electrons are donated by one atom only.

Conditions required for coordinate bond formation :

- ♦ One atom must have lone pair of electrons.
- ♦ Another atom must have the tendency to take that lone pair of electrons.

Covalent Bond

Covalent bond formation takes place due to the sharing of electrons.

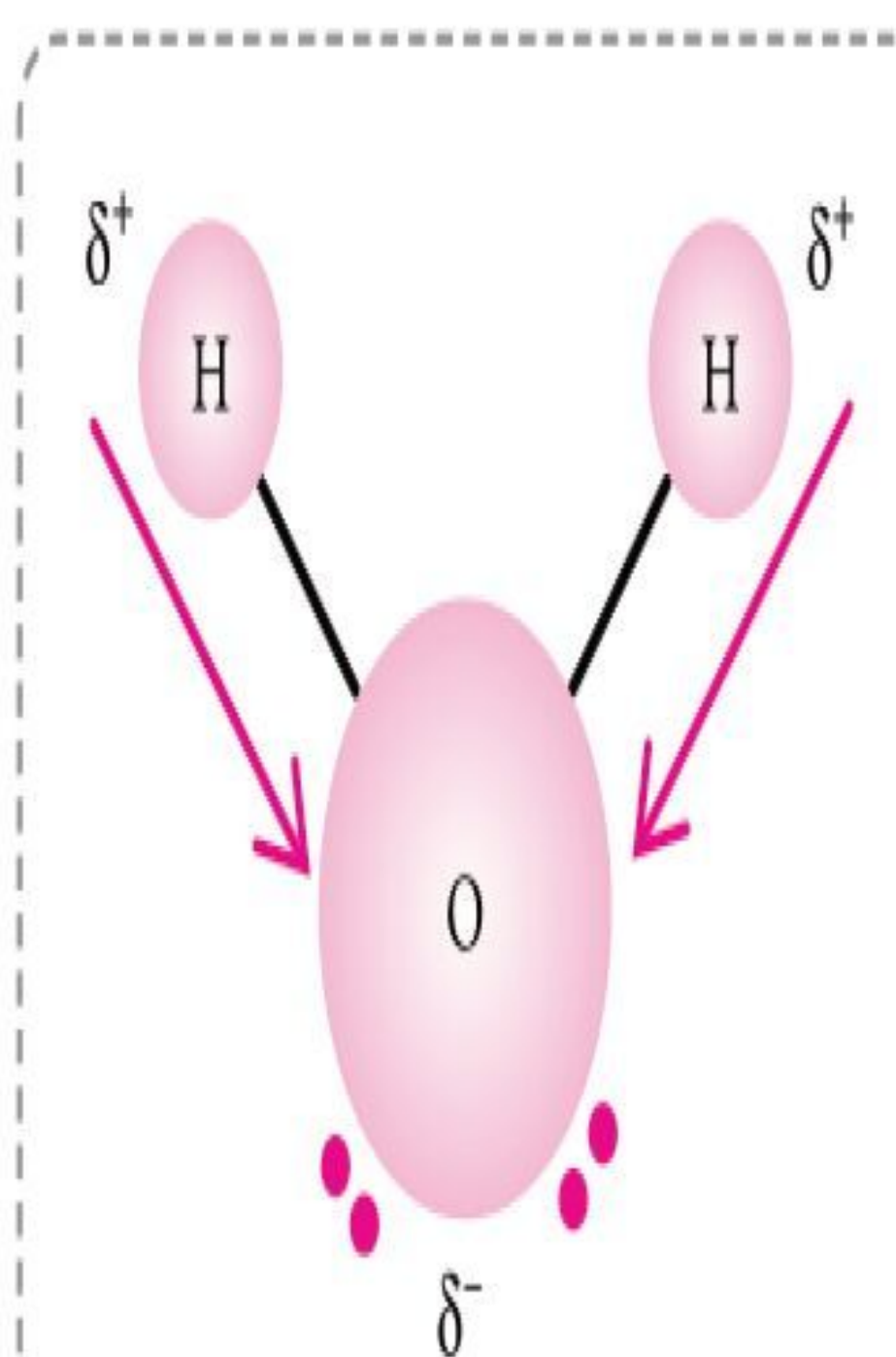


Factors favourable for covalent bond formation :

- ♦ Ionisation enthalpies of combining atoms must be comparable.
- ♦ Electron gain enthalpies of combining atoms must be comparable.

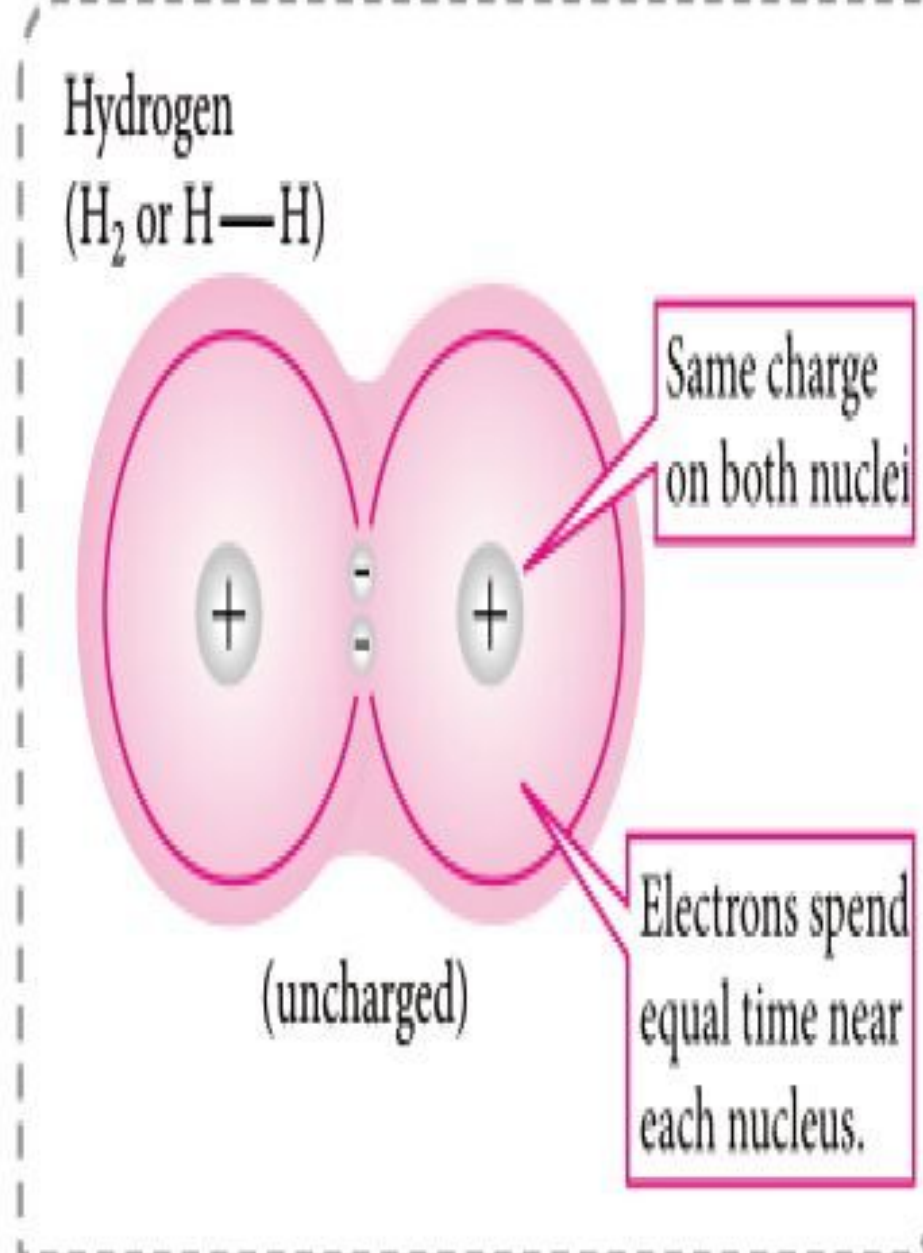
Polar Covalent Bond

- ♦ Between two atoms with different abilities to attract electrons.
- ♦ Molecule itself becomes polar when the shape of the molecule allows a permanent separation of charge.



Non-Polar Covalent Bond

- ♦ Between two atoms with same abilities to attract electrons.
- ♦ Some linear molecules (of different atoms) can be non-polar because the separated charge cancel each other.





CBSE

warm-up!

CLASS-XI

TERM-I OBJECTIVE TYPE QUESTIONS

Practice Paper 2021

Time allowed : 90 minutes
Maximum marks : 35

GENERAL INSTRUCTIONS

1. The Question Paper contains three sections.
2. Section A has 25 questions. Attempt any 20 questions.
3. Section B has 24 questions. Attempt any 20 questions.
4. Section C has 6 questions. Attempt any 5 questions.
5. All questions carry equal marks.
6. There is no negative marking.

- Some Basic Concepts of Chemistry
- Structure of Atom
- Classification of Elements and Periodicity in Properties
- Chemical Bonding and Molecular Structure
- Redox Reactions
- Hydrogen
- Organic Chemistry : Some Basic Principles and Techniques

SECTION - A

This section consists of 25 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation.

1. Which of the following is an electrophilic reagent?
(a) H_2O (b) NH_3 (c) OH^- (d) NO_2^+
2. Uncertainty in position of an electron (mass = 9.1×10^{-28} g) moving with a velocity of 3×10^4 cm/s accurate up to 0.001% will be
(a) 1.93 cm (b) 3.84 cm
(c) 5.76 cm (d) 7.68 cm.
3. M^{3+} has electronic configuration as $[\text{Ar}]3d^{10}4s^2$, hence the element M lies in
(a) s-block (b) p-block
(c) d-block (d) f-block.
4. The maximum number of 90° angles between bond pair-bond pair of electrons is observed in hybridisation
(a) dsp^2 (b) sp^3d
(c) dsp^3 (d) sp^3d^2
5. Heterolysis of a carbon-chlorine bond produces
(a) two free radicals
(b) two carbocations
(c) one cation and one anion
(d) two carbanions.
6. The number of water molecules are maximum in
(a) 1.8 gram of water (b) 18 gram of water
(c) 18 moles of water (d) 180 m mol of water
7. Which of the following sets of elements is arranged in order of increasing electronegativity based on Pauling's scale?
(a) $\text{S} < \text{Si} < \text{P}$ (b) $\text{Si} < \text{P} < \text{S}$
(c) $\text{S} < \text{P} < \text{Si}$ (d) $\text{P} < \text{Si} < \text{S}$
8. Mass percentage of deuterium in heavy water is
(a) same as that of protium in water
(b) 11.1
(c) 20.0
(d) cannot be predicted.

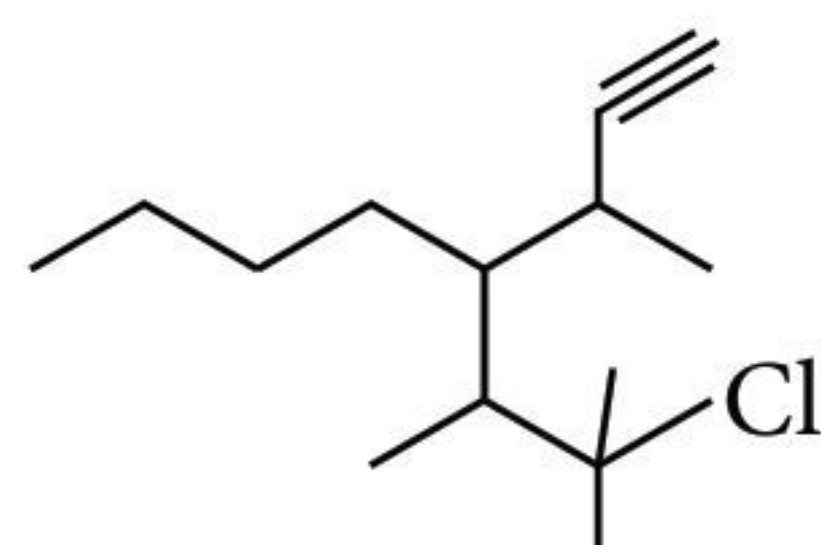
9. Find the disproportionation reaction among the following.
- $\text{Te}_{(s)} + \text{NO}_{3(aq)}^- \longrightarrow \text{TeO}_{2(s)} + \text{NO}_{(g)}$
 - $\text{H}_2\text{O}_{2(aq)} + \text{Fe}_{(aq)}^{2+} \longrightarrow \text{Fe}_{(aq)}^{3+} + \text{H}_2\text{O}_{(l)}$
 - $\text{Mn}_{(s)} + \text{NO}_{3(aq)}^- \longrightarrow \text{Mn}_{(aq)}^{2+} + \text{NO}_{2(g)}$
 - $\text{Mn}_{(aq)}^{3+} \longrightarrow \text{MnO}_{2(s)} + \text{Mn}_{(aq)}^{2+}$
10. The dipole moment of vinyl chloride is lower than that of ethyl chloride. This is due to
- resonance effect
 - inductive effect
 - electromeric effect
 - hyperconjugation effect.
11. The amount of energy required to remove the electron from a Li^{2+} ion in its ground state is how many times greater than the amount of energy needed to remove the electron from an H atom in its ground state?
- 2
 - 9
 - 4
 - 6
12. If the fertilizers listed below are priced according to their nitrogen content, which will be the least expensive per 50 kg bag?
- Urea, $(\text{NH}_2)_2\text{CO}$
 - Ammonia, NH_3
 - Ammonium nitrate, NH_4NO_3
 - Guanidine, $\text{HNC}(\text{NH}_2)_2$
13. Which is the correct order of increasing energy of the listed orbitals in the atom of titanium? (At. no. $Z = 22$)
- $4s\ 3s\ 3p\ 3d$
 - $3s\ 3p\ 3d\ 4s$
 - $3s\ 3p\ 4s\ 3d$
 - $3s\ 4s\ 3p\ 3d$
14. Extent of hydration of Na^+ , Mg^{2+} , Al^{3+} is in order
- $\text{Na}^+ < \text{Al}^{3+} < \text{Mg}^{2+}$
 - $\text{Na}^+ < \text{Mg}^{2+} < \text{Al}^{3+}$
 - $\text{Al}^{3+} < \text{Mg}^{2+} < \text{Na}^+$
 - $\text{Mg}^{2+} < \text{Na}^+ < \text{Al}^{3+}$
15. The paramagnetic property of the oxygen molecule is due to the presence of unpaired electrons present in
- $(\sigma 2p_x)^1$ and $(\sigma^* 2p_x)^1$
 - $(\sigma 2p_x)^1$ and $(\pi 2p_y)^1$
 - $(\pi^* 2p_x)^1$ and $(\pi^* 2p_y)^1$
 - $(\pi^* 2p_y)^1$ and $(\pi 2p_y)^1$
16. What is the ratio of the masses of oxygen that are combined with 1.08 g of nitrogen in the compounds N_2O_3 and NO ?
- 2 : 3
 - 1 : 3
 - 3 : 2
 - 1 : 2
17. If the principal quantum number $n = 6$, the correct sequence of filling of electrons will be
- $ns \rightarrow np \rightarrow (n-1)d \rightarrow (n-2)f$
 - $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$
 - $ns \rightarrow (n-1)d \rightarrow (n-2)f \rightarrow np$
 - $ns \rightarrow (n-2)f \rightarrow np \rightarrow (n-1)d$
18. 100 mL of tap water containing $\text{Ca}(\text{HCO}_3)_2$ was titrated with N/50 HCl with methyl orange as an indicator. If 30 mL of HCl were required, the temporary hardness as parts of CaCO_3 per 10^6 parts of water is
- 150
 - 300
 - 450
 - 600
19. Which combination appears odd w.r.t. oxidation number per atom of the underlined species?
- H_2SO_5 , $\text{H}_2\text{S}_2\text{O}_8$, $\text{K}_2\text{Cr}_2\text{O}_7$
 - CrO_5 , CrO_4^{2-} , SO_4^{2-}
 - Both (a) and (b)
 - None of these
20. Cortisone is a molecular substance containing 21 atoms of carbon per molecule. The mass percentage of carbon in cortisone is 69.98%. Its molar mass is
- 176.5
 - 252.2
 - 287.6
 - 360.1
21. Which of the following properties displays progressive increase down the group in the Bohr's periodic table?
- Electronegativity
 - Electron affinity
 - Ionisation potential
 - Size of the atom
22. Two particles A and B are in motion. If the wavelength associated with the particle A is 5×10^{-8} m, calculate the wavelength of particle B if its momentum is half of A.
- 10^{-8} m
 - 10^{-6} m
 - 10^{-5} m
 - 10^{-7} m
23. Vitamin C (ascorbic acid) contains 40.92% C, 4.58% H and 54.50% of O by mass. If molecular weight of ascorbic acid is 176 g mol^{-1} , what is the molecular formula?
- $\text{C}_3\text{H}_2\text{O}_3$
 - $\text{C}_4\text{H}_3\text{O}$
 - $\text{C}_6\text{H}_8\text{O}_6$
 - $\text{C}_3\text{H}_4\text{O}_3$
24. The bond dissociation energy of B—F in BF_3 is 646 kJ mol^{-1} whereas that of C—F in CF_4 is 515 kJ mol^{-1} . The correct reason for higher B—F bond dissociation energy as compared to that of C—F is
- smaller size of B-atom as compared to that of C-atom.
 - stronger σ -bond between B and F in BF_3 as compared to that between C and F in CF_4 .
 - significant $p\pi$ - $p\pi$ interaction between B and F in BF_3 whereas there is no possibility of such interaction between C and F in CF_4 .
 - lower degree of $p\pi$ - $p\pi$ interaction between B and F in BF_3 than that between C and F in CF_4 .

25. Which of the following hydrides is/are polymeric in nature?
 (a) BeH_2 (b) LiH
 (c) MgH_2 (d) Both (a) and (c)

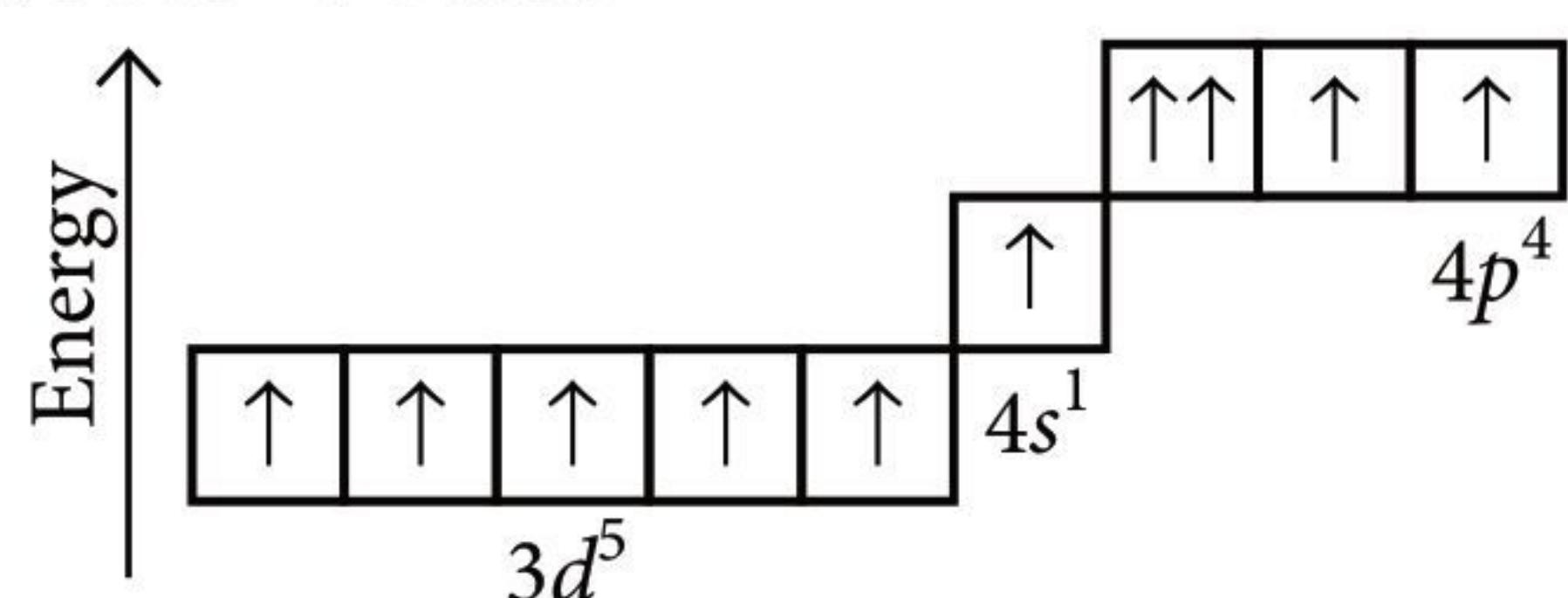
SECTION - B

This section consists of 24 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation.

26. In IUPAC system, for $-\text{NH}_2$ group, the prefix and suffix used are respectively.
 (a) nitro and amine (b) amine and amino
 (c) amino and amine (d) nitrile and amino
27. Oxidation state of nitrogen is incorrectly given for
- | Compound | Oxidation state |
|--|-----------------|
| (a) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ | -3 |
| (b) NH_2OH | -1 |
| (c) $(\text{NH}_4)_2\text{SO}_4$ | +2 |
| (d) Mg_3N_2 | -3 |
28. Which of the following is not correct according to MOT?
 (a) $\sigma = \psi_A - \psi_B$ and $\sigma^* = \psi_A + \psi_B$
 (b) During the formation of molecular orbitals, atomic orbitals lose their identity.
 (c) Two atomic orbitals combine to form two molecular orbitals.
 (d) Bonding molecular orbitals have lower energy than antibonding molecular orbitals.
29. What is the correct IUPAC name of the compound shown below?



- (a) 4-(2-Chloro-1,2-dimethylpropyl)-3-methyloct-1-yne
 (b) 4-Butyl-6-chloro-3,5,6,6-tetramethylhept-1-yne
 (c) 4-Butyl-2-chloro-2,3,5-trimethylhept-6-yne
 (d) 4-Butyl-6-chloro-3,5,6-trimethylhept-1-yne
30. In the following electronic configuration, some rules have been violated



- I : Hund II : Pauli's exclusion III : Aufbau
 (a) I and II (b) I and III
 (c) II and III (d) I, II and III

31. If the density of methanol is 0.793 kg L^{-1} , what is its volume needed for making 2.5 L of its 0.25 M solution?
 (a) 2.5 L (b) 0.025 L (c) 0.25 L (d) 25 L
32. An element of atomic weight 40 has 2, 8, 8, 2 as the electronic configuration. Which one of the following statements regarding this element is not correct?
 (a) It belongs to II group of the periodic table.
 (b) It has 20 neutrons.
 (c) The formula of its oxide is MO_2 .
 (d) It belongs to 4th period of the periodic table.
33. Consider the following table comparing ionic radius :

Ion \rightarrow	N^{3-}	O^{2-}	F^-	Na^+	Mg^{2+}
Number of electrons	10	10	10	10	10
Number of nuclear protons	7	8	9	11	12
Ionic radius (pm)	146	140	133	98	79

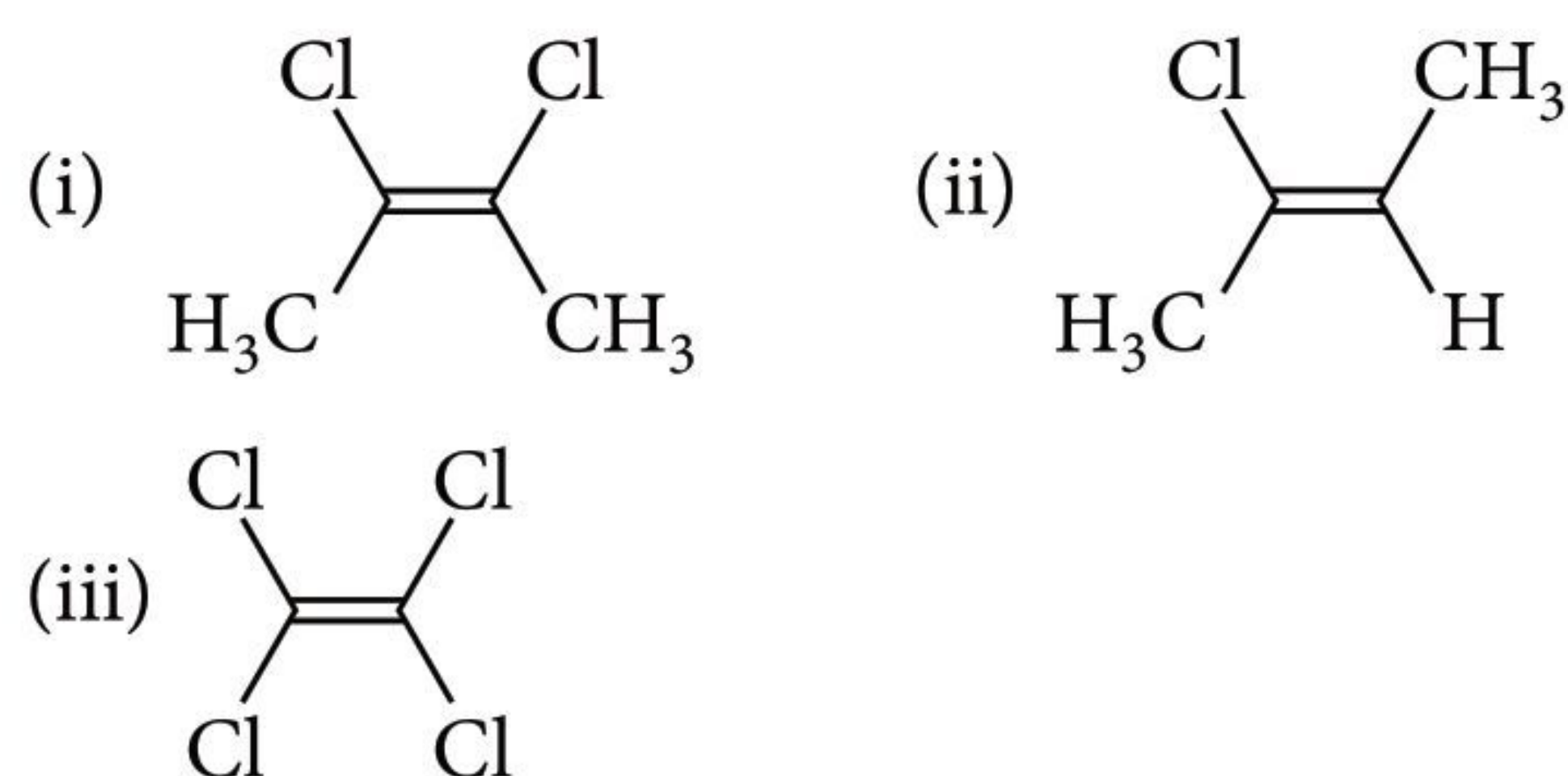
Select the correct option in terms of size.

- (a) $\text{Na} > \text{Na}^+$ (b) $\text{Mg} > \text{Mg}^+ > \text{Mg}^{2+}$
 (c) $\text{F}^- > \text{F}$ (d) All of these
34. On heating, 100 g of $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ will loose _____ % of water.
 (a) 44.1 (b) 65.3 (c) 17.4 (d) 34.7
35. Heavy water is used as
 (a) moderator in nuclear reactors
 (b) exchange reactions for study of reaction mechanisms
 (c) hair bleach
 (d) both (a) and (b).
36. In the reaction
 $\text{S}_8 + 12\text{OH}^- \rightarrow 4\text{S}^{2-} + 2\text{S}_2\text{O}_3^{2-} + 6\text{H}_2\text{O}$
 S has undergone oxidation and reduction. Which of the following statement is true?
 (a) In S^{2-} , sulphur has been oxidised and in $\text{S}_2\text{O}_3^{2-}$ sulphur has been reduced.
 (b) In both S^{2-} and $\text{S}_2\text{O}_3^{2-}$ ions sulphur has been oxidised.
 (c) In both S^{2-} and $\text{S}_2\text{O}_3^{2-}$ ions sulphur has been reduced.
 (d) None of these.

37. Which of the following C — C bond has the smallest bond length?

- (a) $\text{>C} - \text{C} \equiv$ (b) $\text{>C} - \text{C} =$
 (c) $\equiv \text{C} - \text{C} \equiv$ (d) $= \text{C} - \text{C} \equiv$

38. Identify correct dipole moment order in the following compounds :



- (a) $i > ii > iii$ (b) $ii > iii > i$
 (c) $i > iii > ii$ (d) $iii > i > ii$

39. The de Broglie wavelength of 1 mg grain of sand blown by a 20 ms^{-1} wind is

- (a) $3.3 \times 10^{-29} \text{ m}$ (b) $3.3 \times 10^{-21} \text{ m}$
 (c) $3.3 \times 10^{-49} \text{ m}$ (d) $3.3 \times 10^{-42} \text{ m}$

40. The molecular formula of a commercial resin used for exchanging ions in water softening is $\text{C}_8\text{H}_7\text{SO}_3\text{Na}$ (Mol. wt. 206). What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin?

- (a) $\frac{2}{309}$ (b) $\frac{1}{412}$ (c) $\frac{1}{103}$ (d) $\frac{1}{206}$

41. The correct bond order of P — O bond in PO_4^{3-} is

- (a) 1.0 (b) 1.25 (c) 1.50 (d) 2.5

42. Which of the following sets of quantum numbers are not possible?

- (a) $n = 1, l = 0, m_l = 0, m_s = -\frac{1}{2}$
 (b) $n = 1, l = 1, m_l = 0, m_s = +\frac{1}{2}$
 (c) $n = 2, l = 1, m_l = 0, m_s = -\frac{1}{2}$
 (d) $n = 3, l = 1, m_l = 0, m_s = +\frac{1}{2}$

43. Calculate the number of millilitres at STP of H_2S gas needed to precipitate cupric sulphide completely from 100 mL of a solution containing 0.75 g of CuCl_2 in 1 L.

- (a) 21.4 (b) 14.2 (c) 41.2 (d) 125

44. The first four ionisation energy values of an element are 191, 578, 872 and 5962 kcal. The number of valence electrons in the element is

- (a) 1 (b) 2 (c) 3 (d) 4

45. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : Oxidation number of carbon in CH_2O is zero.

Reason : CH_2O , formaldehyde, is a covalent compound.

Select the most appropriate answer from the options given below.

- (a) Both A and R are true and R is the correct explanation of A.
 (b) Both A and R are true but R is not the correct explanation of A.
 (c) A is true but R is false.
 (d) A is false but R is true.

For the
SCIENTIST in



Uranium surprises scientists with strong covalent bond!!

Uranium forms an unusually strong triple covalent bond with nitrile groups, confounding predictions about the bond strength of actinides compared with the remainder of the periodic table.

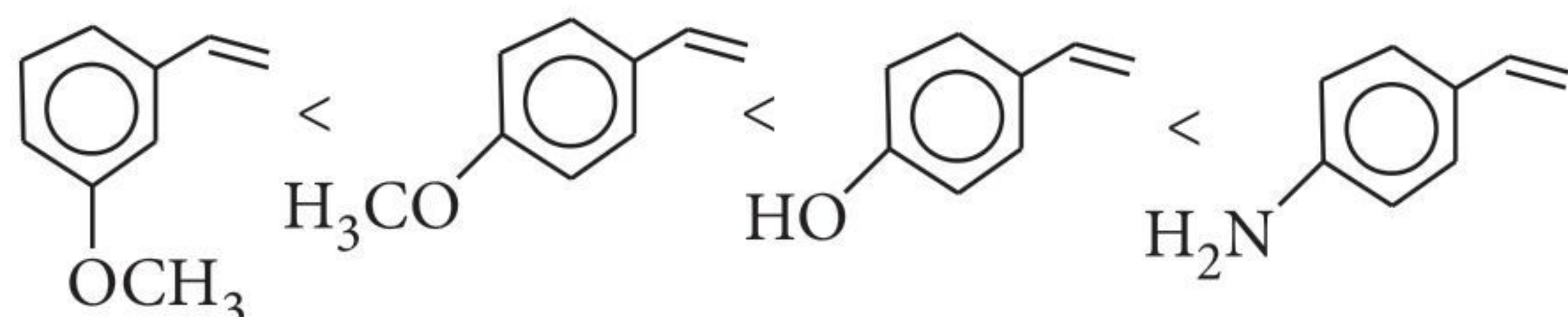
Elements usually follow a pattern in the strength of their covalent bonds, forming more ionic bonds with groups 1 and 2 and the covalency increases as you move across the periodic table. While the bond strengths of actinides have not been studied in depth, they are likely to sit between the ionic lanthanides and the more covalent d-block elements.

However, computational analysis had suggested that uranium, an actinide, forms stronger covalent bonds than the transition metals – chromium, molybdenum and tungsten – in group 6. A group of scientists at the University of Manchester, UK, now decided to investigate the covalency of uranium's bonds experimentally to see if the predictions held up.

The team used nitrogen nuclear magnetic resonance (^{15}N NMR) spectroscopy to probe a terminal uranium(VI) nitride complex, and found the nitrogen in the U–N triple bond had a very large chemical shift. The team then used density functional theory calculations, along with a technique known as NMR shielding tensor analysis, to determine the bond strength. These indicated it was more covalent than equivalent bonds in elements in group 4-6.

46. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : Relative reactivity towards electrophilic addition is



Reason : Electron releasing group stabilizes carbocation. More the +M effect, more is stability of $-\overset{+}{C}-$.

Select the most appropriate answer from the options given below.

- (a) Both A and R are true and R is the correct explanation of A.
 (b) Both A and R are true but R is not the correct explanation of A.
 (c) A is true but R is false.
 (d) A is false but R is true.

47. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : Saline hydrides are non-volatile, non-conducting and crystalline solids.

Reason : Saline hydrides are compounds of hydrogen with most of the *p*-block elements.

Select the most appropriate answer from the options given below.

- (a) Both A and R are true and R is the correct explanation of A.
 (b) Both A and R are true but R is not the correct explanation of A.
 (c) A is true but R is false.
 (d) A is false but R is true.

48. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : Bohr model of hydrogen atom ignores dual behaviour of matter.

Reason : Bohr regarded electron as a charged particle moving in well defined circular orbits about nucleus.

Select the most appropriate answer from the options given below.

- (a) Both A and R are true and R is the correct explanation of A.

- (b) Both A and R are true but R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

49. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : 1 amu equals to 1.66×10^{-24} g.

Reason : 1.66×10^{-24} g equals to $\frac{1}{12}$ th mass of C_{12} atom.

Select the most appropriate answer from the options given below.

- (a) Both A and R are true and R is the correct explanation of A.
 (b) Both A and R are true but R is not the correct explanation of A.
 (c) A is true but R is false.
 (d) A is false but R is true.

SECTION - C

This section consists of 6 multiple choice questions with an overall choice to attempt any 5. In case more than desirable number of questions are attempted, ONLY first 5 will be considered for evaluation.

50. Match the List I with List II and select the correct answer using the codes given below the lists :

List I		List II		
P.	XeF ₄	1.	sp^3d , see-saw	
Q.	SF ₄	2.	sp^3d^2 , square planar	
R.	SF ₆	3.	sp^3d^3 , distorted octahedral	
S.	XeF ₆	4.	sp^3d^2 , octahedral	
	P	Q	R	S
(a)	2	1	4	3
(b)	4	3	2	1
(c)	2	1	3	4
(d)	1	2	4	3

51. Which of the following analogies is correct?

- (a) 4480 mL of CO₂ at STP : 0.2 mole :: 4480 mL of O₂ at STP : 0.1 mole
 (b) 0.1 g – atom of iron : 0.1 mole :: 0.2 g – atom of Cu : 0.2 mole
 (c) 1.5×10^{23} molecules of oxygen gas : 0.25 mole :: hydrogen gas : 1 mole
 (d) 1120 cc of CO₂ gas : 2.2 g :: 1120 cc of H₂ : 0.1 g

52. Complete the following analogy:

Oxidation : A , Reduction : B

- (a) A : Removal of oxygen, B : Addition of oxygen
 (b) A : Addition of hydrogen, B : Removal of hydrogen
 (c) A : Increase in valency of an electropositive element, B : Decrease in valency of an electropositive element
 (d) A : gain of electron, B : loss of electron

Read the passage given below and answer the following questions 53-55.

The energy required to pull the most loosely bound electron from an atom is known as ionization potential. It is expressed in electron volts. The value of ionization potential depends on three factors: (i) the charge on the nucleus (ii) the atomic radius and (iii) the screening effect of inner electron shells. The ionization energies, electron affinities, electronegativities, atomic and ionic radii and other physical properties usually shown a regular pattern of change within a group or along a period with some irregularities.

Ionization energies of five elements in kcal/mol are given below :

Atom	I	II	III
P	300	549	920
Q	99	734	1100
R	118	1091	1652
S	176	347	1848
T	150	2665	3945

53. The element having most stable oxidation state +2 is

- (a) Q (b) R (c) S (d) T

54. If Q reacts with fluorine and oxygen, the molecular formulae of fluoride and oxide will be respectively

- (a) QF₃, Q₂O₃ (b) QF, Q₂O
 (c) QF₂, QO (d) none of these

55. Which of the elements given is having most metallic character?

- (a) P (b) Q (c) R (d) T

SOLUTIONS

1. (d): Electron deficient species act as electrophiles i.e., NO₂⁺.

$$2. (a): \Delta x \cdot \Delta v = \frac{h}{4\pi m} ; \Delta x = \frac{h}{4\pi m \Delta v}$$

$$= \frac{6.626 \times 10^{-27}}{4\pi \times 9.1 \times 10^{-28} \times 3 \times 10^4 \times \frac{0.001}{100}} = 1.93 \text{ cm}$$

3. (b): M³⁺ : [Ar]3d¹⁰4s²

M : [Ar]3d¹⁰4s²4p³

Three electrons have been removed from 4p-sub-shell. Thus, M is a p-block element.

4. (d)

5. (c)

$$6. (c): 1.8 \text{ gram of water} = \frac{6.023 \times 10^{23}}{18} \times 1.8$$

$$= 6.023 \times 10^{22} \text{ molecules}$$

18 gram of water = 6.023 × 10²³ molecules

18 moles of water = 18 × 6.023 × 10²³ molecules

7. (b): In a period from left to right, the value of electronegativity increases. i.e.,

Si < P < S

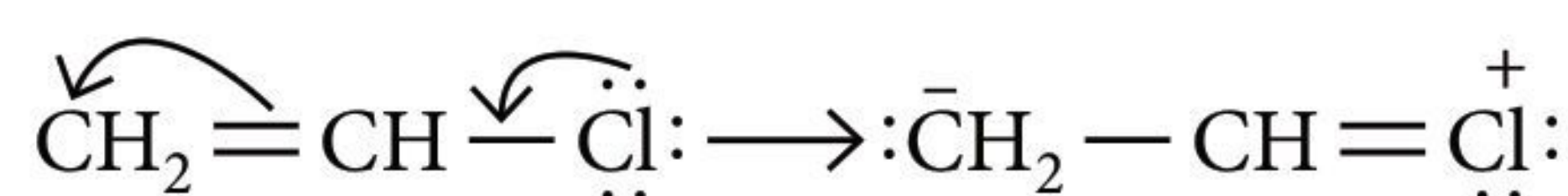
1.8 2.1 2.5 (EN value of Pauling's scale)

8. (c): The formula of heavy water is D₂O, i.e., molecular mass = 20

$$\therefore \% \text{ of deuterium} = \frac{4}{20} \times 100 = 20$$

9. (d)

10. (a): The dipole moment of vinyl chloride is lower than that of CH₃CH₂Cl due to resonance effect.



11. (b): For Li²⁺ ion and H atom in their ground state n = 1

$$\frac{(E_1)_{\text{Li}^{2+}}}{(E_1)_{\text{H}}} = \frac{-\frac{2.18 \times 10^{-18} \times (3)^2}{(1)^2} \text{ J}}{-\frac{2.18 \times 10^{-18} \times (1)^2}{(1)^2} \text{ J}} = 9$$

12. (c): % of N in (NH₂)₂CO = $\frac{28}{60} \times 100 = 46.7\%$

% of N in NH₃ = 14/17 × 100 = 82.3%

% of N in NH₄NO₃ = 28/80 × 100 = 35%

% of N in HNC(NH₂)₂ = 42/59 × 100 = 71.1%

Lower the percentage of N in the fertilizer, lower is its price hence, 50 kg bag of NH₄NO₃ is least expensive.

13. (c): Ti(22) : 1s²2s²2p⁶3s²3p⁶3d²4s²

∴ Order of increasing energy is 3s, 3p, 4s, 3d.

14. (b): Since the radii of Na⁺, Mg²⁺ and Al³⁺ ion (period 3) decrease as Na⁺ > Mg²⁺ > Al³⁺, the hydration energy of these ions is in the increasing order i.e., Na⁺ < Mg²⁺ < Al³⁺.

15. (c)

16. (c) : In N_2O_3 , ratio of mass of O by mass of N

$$= \frac{48.0 \text{ g}}{28.0 \text{ g}} = 1.71$$

In NO , ratio of mass of O by mass of N

$$= \frac{16.0 \text{ g}}{14.0 \text{ g}} = 1.14$$

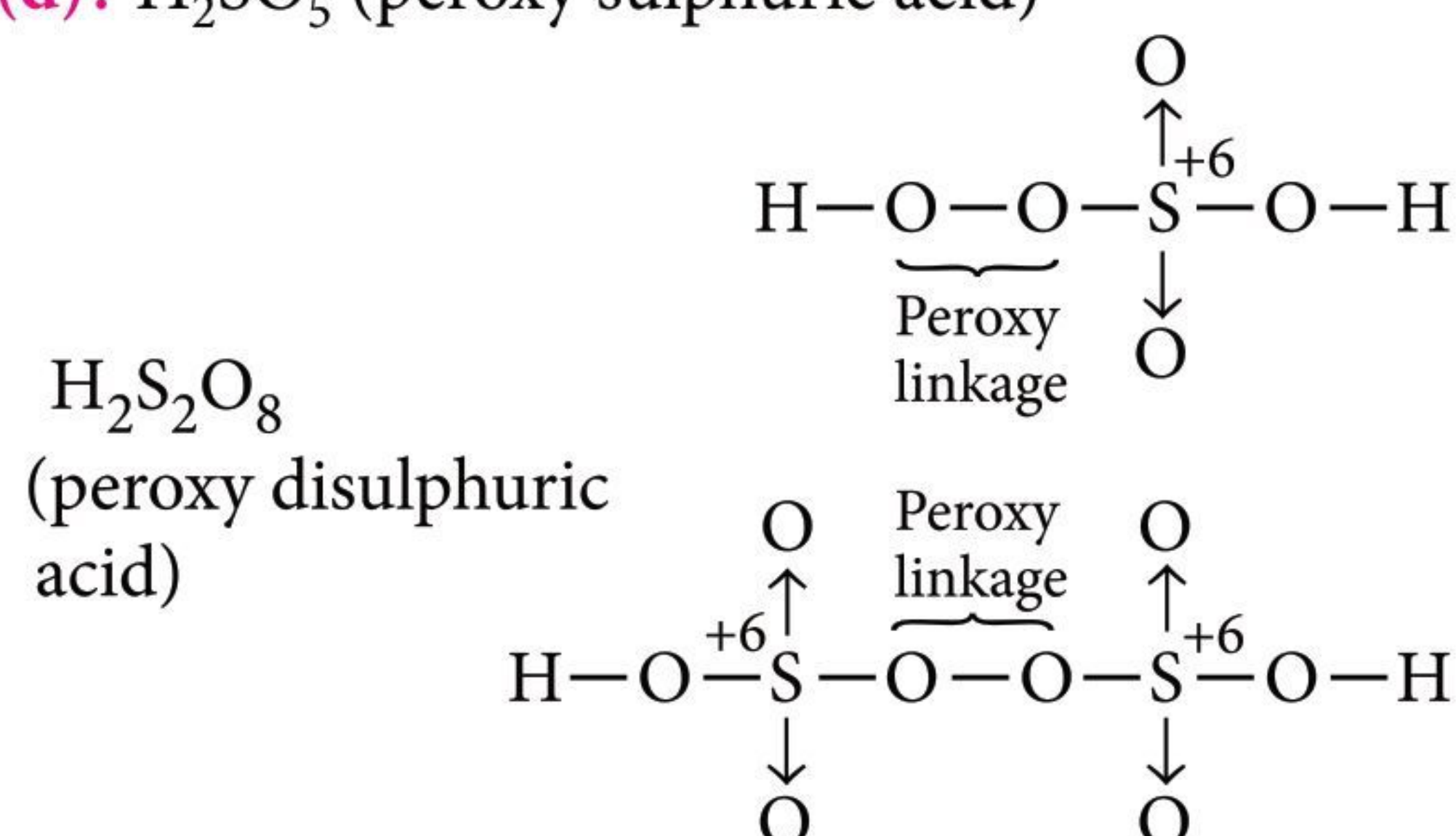
Ratio of masses of oxygen that are combined with

$$1.08 \text{ g of nitrogen in } N_2O_3 \text{ and } NO = \frac{1.71/1.08}{1.14/1.08} = \frac{3}{2}$$

17. (b)

18. (b)

19. (d) : H_2SO_5 (peroxy sulphuric acid)



All of the above sulphur have O.N. = 6

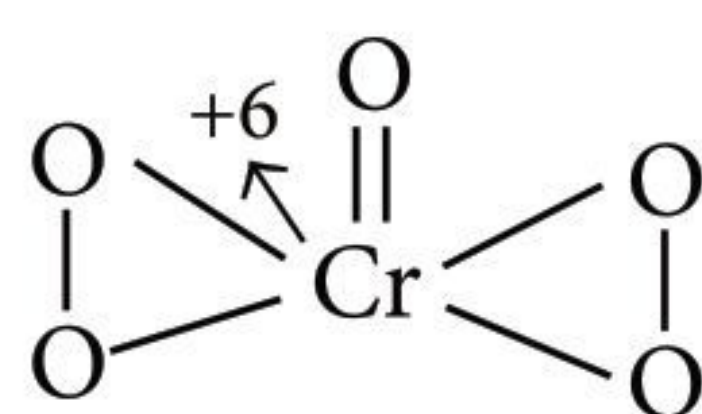
Peroxy linkage ($-\text{O}-\text{O}-$) has

-1 O.N. for oxygen,

CrO_5 has two peroxy linkage,

thus O.N. of Cr = +6

$\text{K}_2\text{Cr}_2\text{O}_7$ and CrO_4^{2-} both has +6 oxidation number for Cr. In SO_4^{2-} , sulphur also has +6 oxidation number.



20. (d) : Let molar mass be M .

Mass of 21 carbon atoms = 252

$$\% \text{ of carbon} = \frac{252 \times 100}{M} = 69.98$$

$$\therefore M = 360.1$$

21. (d) : In completely filled shell of an atom, interatomic repulsion is more so have greater size.

$$22. (d) : \lambda_A = \frac{h}{p_A} \text{ and } \lambda_B = \frac{h}{p_B}$$

$$\text{or } \frac{\lambda_A}{\lambda_B} = \frac{p_B}{p_A} = \frac{1}{2} \quad \left(\because p_B = \frac{1}{2} p_A \right)$$

Given : $\lambda_A = 5 \times 10^{-8} \text{ m}$

$$\therefore \frac{5 \times 10^{-8}}{\lambda_B} = \frac{1}{2} \Rightarrow \lambda_B = 10^{-7} \text{ m}$$

23. (c) :

Element	%	Atomic mass	Relative number of atoms	Simplest ratio
C	40.92	12	$\frac{40.92}{12} = 3.41$	$\frac{3.41}{3.41} = 1 \times 3 = 3$
H	4.58	1	$\frac{4.58}{1} = 4.58$	$\frac{4.58}{3.41} = 1.34 \times 3 = 4$
O	54.50	16	$\frac{54.50}{16} = 3.41$	$\frac{3.41}{3.41} = 1 \times 3 = 3$

Hence, empirical formula is $\text{C}_3\text{H}_4\text{O}_3$

Empirical formula weight = $36 + 4 + 48 = 88$

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{176}{88} = 2$$

Thus, molecular formula = (Empirical formula) $\times n$
 $= (\text{C}_3\text{H}_4\text{O}_3) \times 2 = \text{C}_6\text{H}_8\text{O}_6$

24. (c)

25. (d)

26. (c)

27. (c)

28. (a) : According to MOT, $\sigma = \psi_A + \psi_B$ while $\sigma^* = \psi_A - \psi_B$

29. (a)

30. (d)

31. (b) : Density of methanol (CH_3OH) = 0.793 kg L^{-1}

Molecular mass of methanol (CH_3OH)

$$= 12 + 3 + 16 + 1 = 32$$

2.5 L of 0.25 M methanol solution contains

methanol = $2.5 \times 0.25 \times 32 = 20 \text{ g} = 0.020 \text{ kg}$

0.793 kg of methanol is present in volume = 1000 mL

0.020 kg of methanol is present in volume

$$= \frac{1000}{0.793} \times 0.020 = 25.22 \text{ mL} = 0.025 \text{ L}$$

32. (c) : Its valency is 2. So it will form MO type oxide.

33. (d)

34. (c) : Required percentage is equal to the mass percent of water in 100 g of $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$.

$$\text{mol of } \text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O} = \frac{100}{322} = 0.311 \text{ mol}$$

$$\text{mol of } \text{H}_2\text{O} = 0.311 \times 10 = 3.110 \text{ mol}$$

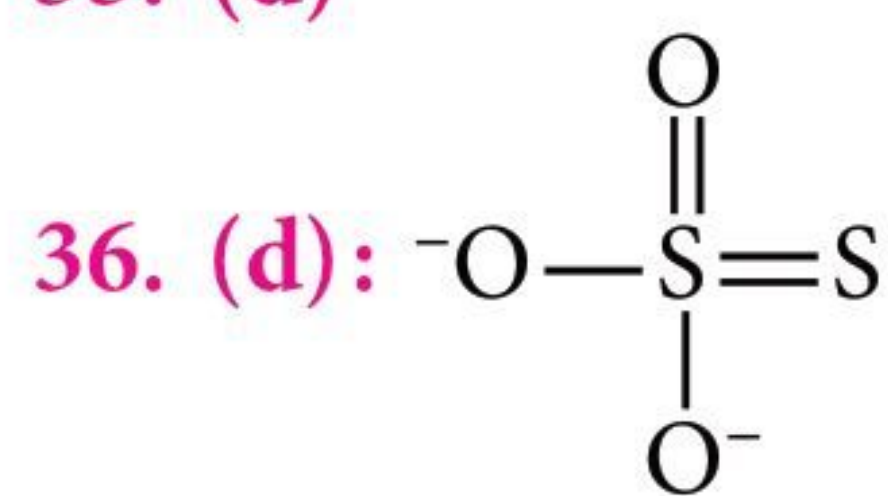
$$\text{mass of } \text{H}_2\text{O in } 3.110 \text{ mol} = 3.110 \times 18 = 56.0 \text{ g}$$

\therefore Percentage of water lost

$$= \frac{\text{Mass of } \text{H}_2\text{O in the compound}}{\text{Molar mass of compound}} \times 100$$

$$= \frac{56.0}{322} \times 100 = 17.4\%$$

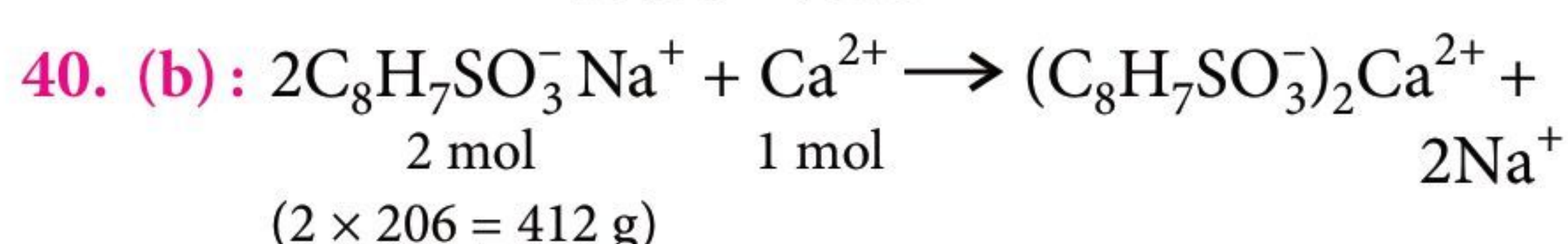
35. (d)



37. (c): Here, both the C-atoms are sp -hybridised having highest s (percentage) character, thereby smallest bond length.

38. (a)

39. (a): $\lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34}}{1 \times 10^{-6} \times 20} = 3.313 \times 10^{-29} \text{ m}$



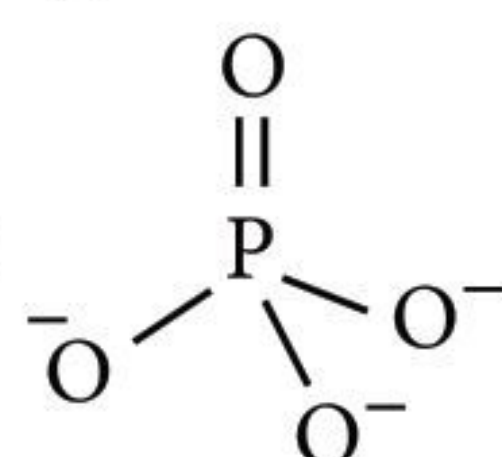
1 mol of $\text{Ca}^{2+} \equiv 412 \text{ g}$ of resin

Maximum uptake of Ca^{2+} ions by the resin

$$= \frac{1 \text{ mol}}{412 \text{ g}} = \frac{1}{412} \text{ mol/g}$$

41. (b): Bond order of P — O bond in

$$= \frac{2+1+1+1}{4} = \frac{5}{4} = 1.25$$



42. (b): It is not possible because when $n = 1, l = 0$ and $l \neq 1$.



Number of moles of H_2S = Number of moles of CuCl_2

$$= \frac{0.75}{134.5} = 0.00576$$

Volume of H_2S = $0.00576 \times 22400 = 125 \text{ mL}$

44. (c): Since there is a large jump in the third and fourth ionisation energies, therefore after removal of the third electron, the cation has the inert gas configuration. Therefore, the valency of the element is 3.

45. (a)

46. (a)

47. (c)

48. (a): Bohr model contradicts Heisenberg's uncertainty principle.

49. (a): 12 g of C-12 contains 6.023×10^{23} atoms.

$$\therefore 1 \text{ amu} = \frac{1}{12} \times \frac{12}{6.023 \times 10^{23}} = 1.66 \times 10^{-24} \text{ g}$$

50. (a): P-2; Q-1; R-4; S-3

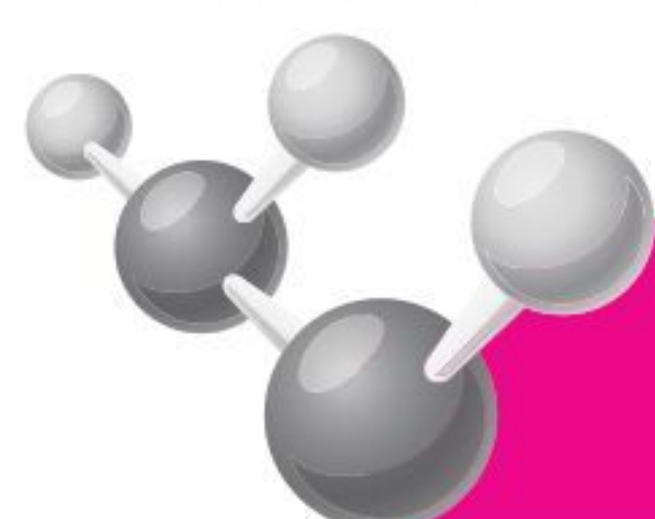
51. (d)

52. (c)

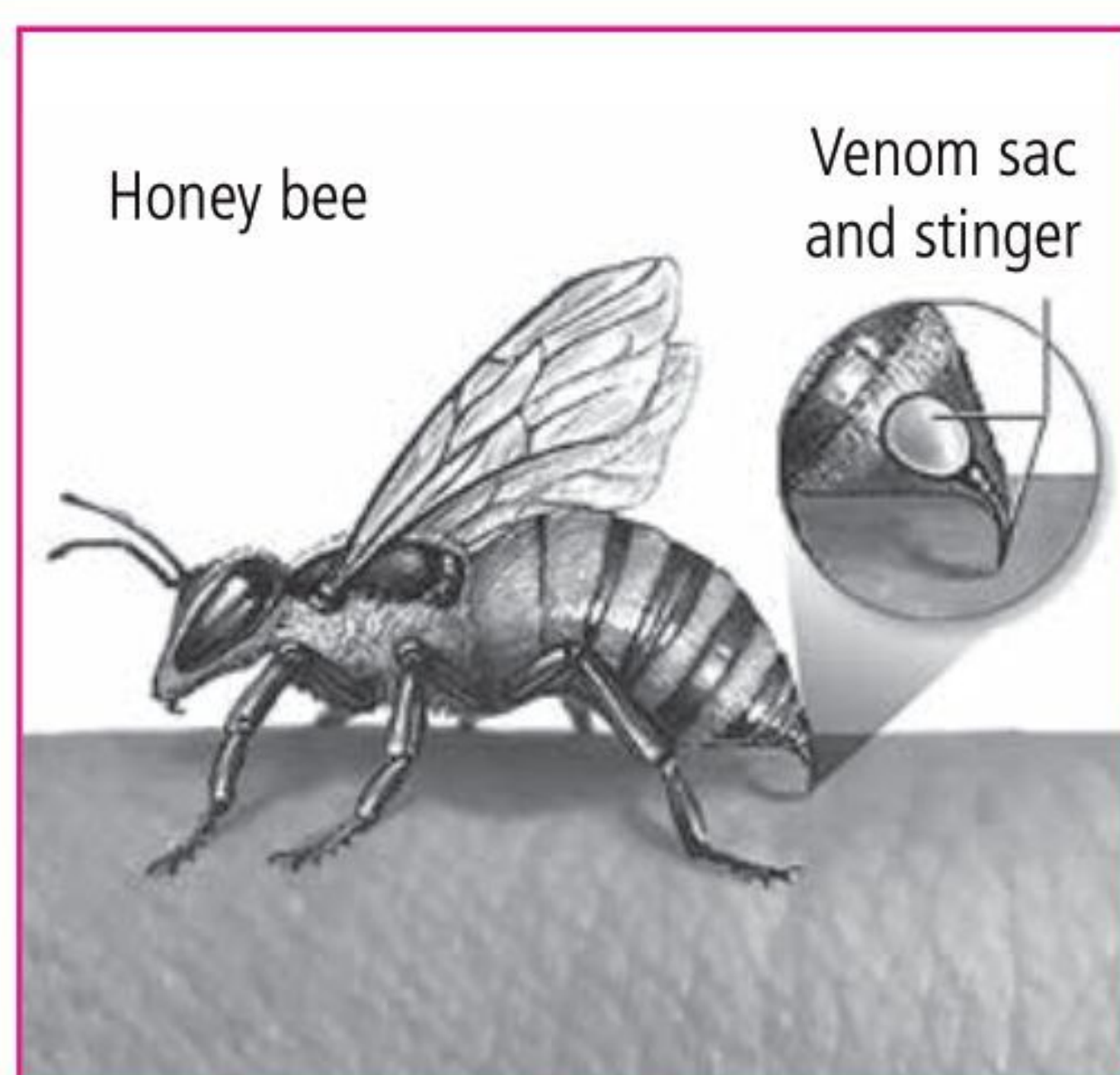
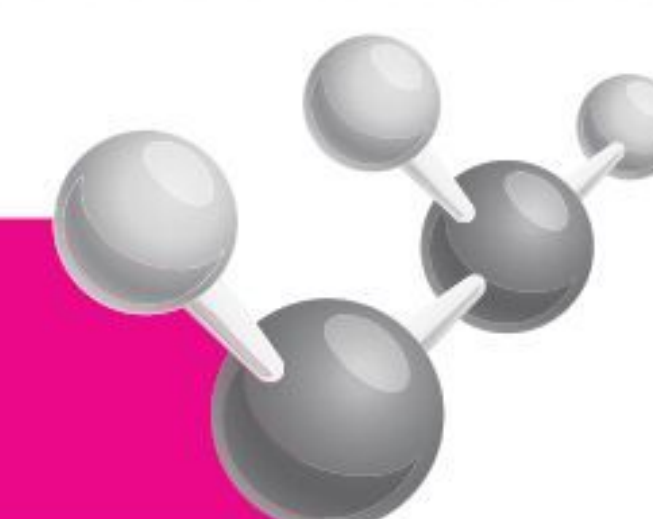
53. (c): $I.E._3$ of S is abnormally higher.

54. (b): Q is an alkali metal as it shows increase in $I.E._2$ value.

55. (b): Q is having lowest first $I.E.$ and hence most metallic.



3 Amazing Facts You Must Know



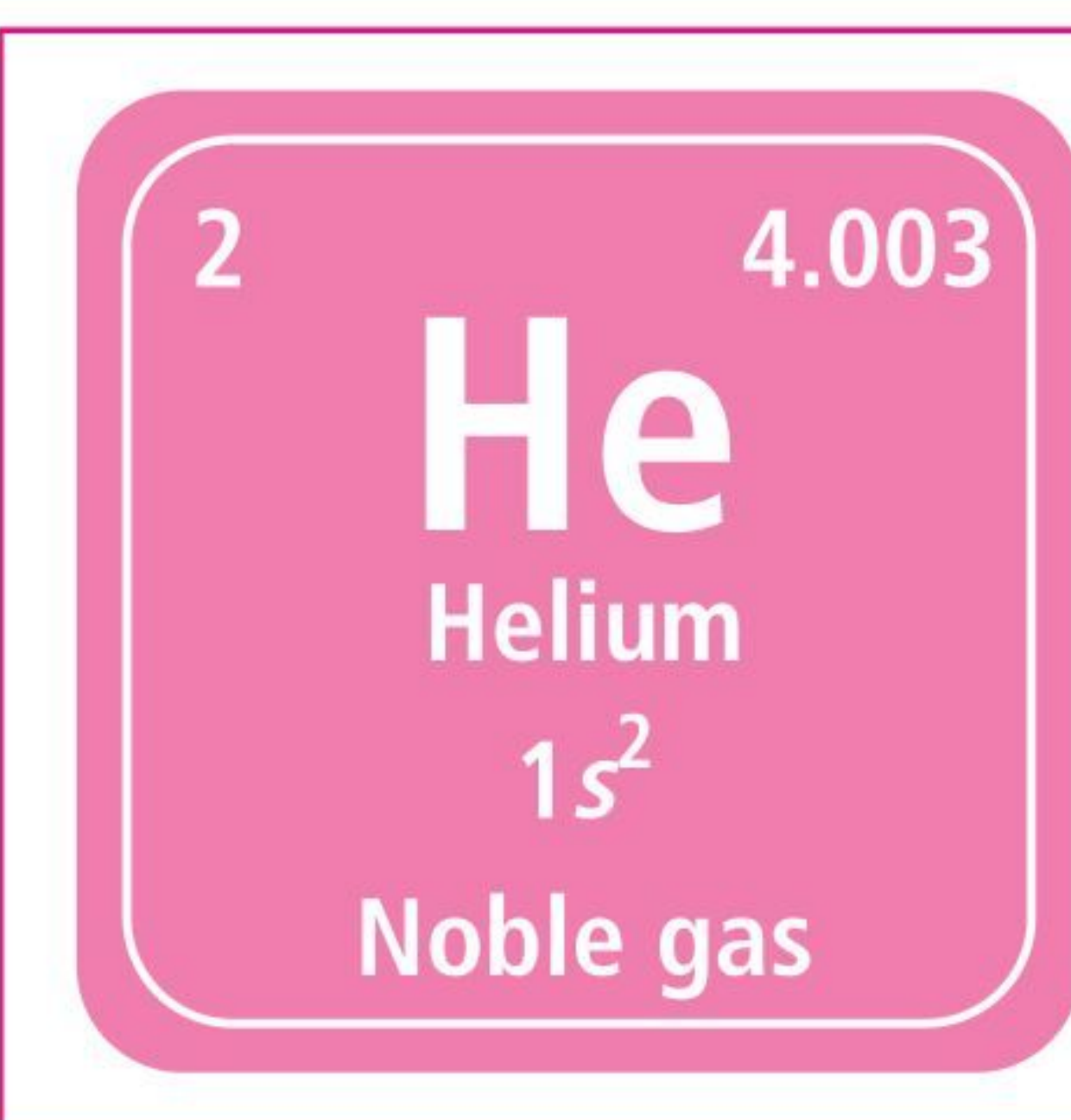
1. The reason of pain we feel from the venom of wasps and bees!

Both venoms contain hyaluronidase, which breaks down the barrier between cells, helping the venom to spread. The pain we feel from the venom of wasps and bees is due to the enzymes in the venom breaking down our cells. Both wasps and bees also signal others of their kind after they sting, so it's a good idea to get far away after the first sting.



2. You need to exceed temperatures of 1000 degrees Celsius to burn a diamond!

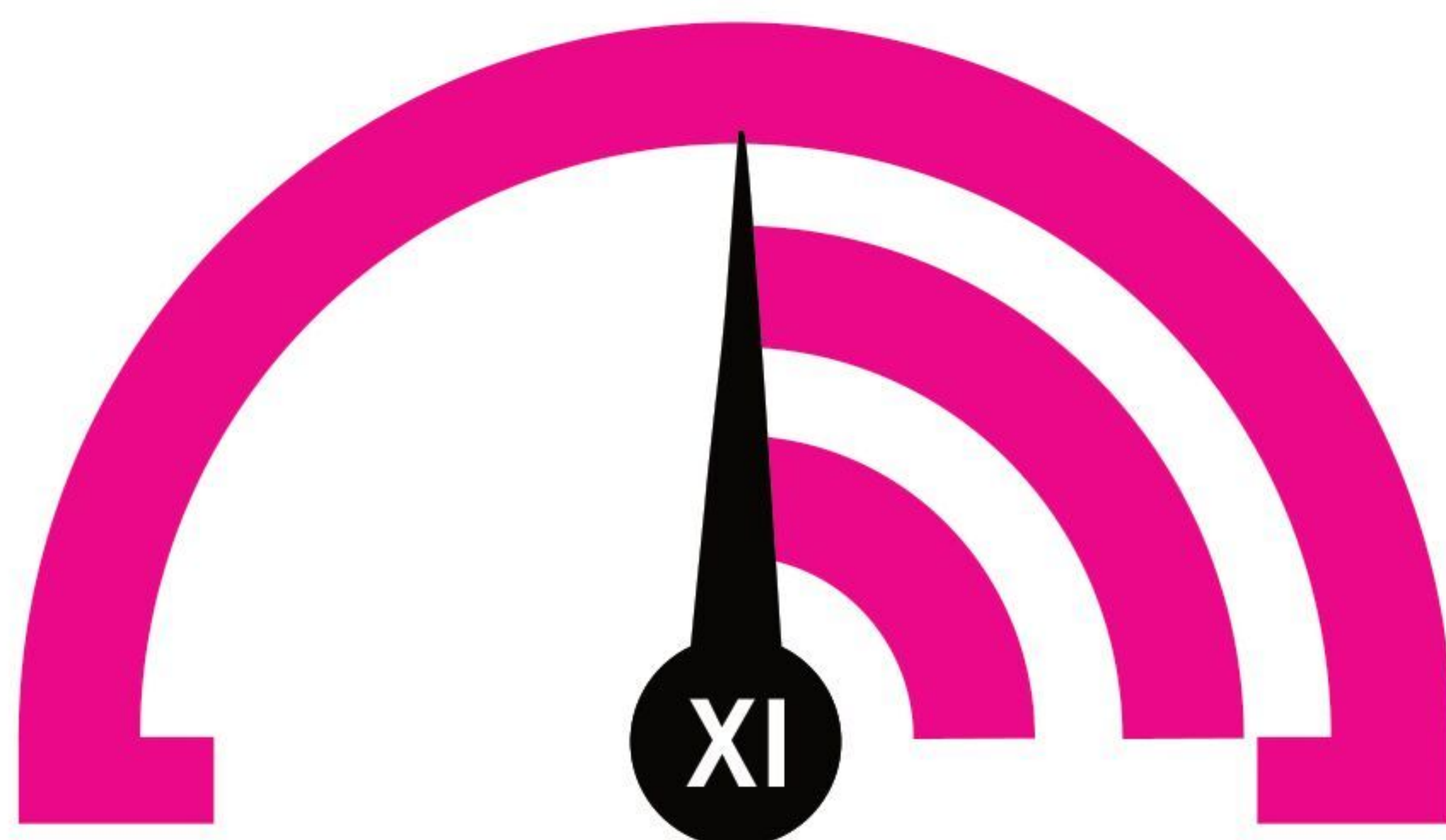
Diamonds don't evaporate at high temperatures since they are under atmospheric pressure. But they can oxidize. If you heat a diamond to a hot enough temperature at 1 atm, it will turn into vapour. If diamond is placed in an oven and the temperature is raised to about 1405° Fahrenheit, it will simply vanish, without even ash remaining. Only a little carbon dioxide will be released.



3. The only known substance that cannot freeze at normal atmospheric pressure is helium!

Helium is the only element that cannot be solidified by sufficient cooling at normal atmospheric pressure; it is necessary to apply pressure of 25 atmospheres at a temperature of 1 K (−272 °C, or −458 °F) to convert it to its solid form.

MONTHLY TEST DRIVE



This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120

The *p*-Block Elements (Group 13 & 14)

Time Taken : 60 Min.

NEET

Only One Option Correct Type

- Which of the following is true for red lead?
 - It gives a red brown precipitate of PbO_2 when reacted with concentrated HNO_3 .
 - It evolves H_2 with H_2SO_4 .
 - It decomposes above 470°C into PbO and O_2 .
 - Both (a) and (c).
- Incorrect statement about Ge is
 - Ge is a metalloid
 - $\text{Ge}(\text{OH})_2$ is amphoteric
 - GeCl_2 is more stable than GeCl_4
 - Ge-Ge bond energy is lesser than that of Si-Si.
- Aluminium is obtained by
 - reduction of Al_2O_3 with coke
 - electrolysis of Al_2O_3 dissolved in Na_3AlF_6 and CaF_2
 - reduction of Al_2O_3 with chromium
 - heating cryolite and alumina.
- Sodium metal reacts with Al_2O_3 at high temperature to give a sodium compound X. X reacts with carbon dioxide in water to form Y. Y is
 - Na_2CO_3
 - Na_2O_2
 - NaAlO_2
 - Na_2O
- $\text{Na}_2\text{B}_4\text{O}_7 \xrightarrow{740^\circ\text{C}} \text{X} + \text{Y}$
(anhydrous)
(X) and (Y) are
 - boric anhydride and sodium metaborate
 - boric anhydride and sodium peroxide
 - sodium metaborate and sodium peroxide
 - sodium metaborate and sodium borate.
- The element that shows greater ability to form $p\pi-p\pi$ multiple bonds is
 - C
 - Ge
 - Sn
 - Si
- $\text{Be}_2\text{C} + 4\text{H}_2\text{O} \longrightarrow 2\text{X} + \text{CH}_4$
 $\text{X} + 2\text{HCl}_{(\text{aq})} \longrightarrow \text{Y}$
 X and Y formed in the above two reactions are
 - BeCO_3 and $\text{Be}(\text{OH})_2$ respectively
 - $\text{Be}(\text{OH})_2$ and BeCl_2 respectively
 - $\text{Be}(\text{OH})_2$ and $[\text{Be}(\text{OH})_4]\text{Cl}_2$ respectively
 - $[\text{Be}(\text{OH})_4]^{2-}$ and BeCl_2 respectively.
- $\text{Mg}_3\text{B}_2 \xrightarrow{\text{HCl}_{(\text{aq})}} [\text{X}] + \text{MgCl}_2$
 $[\text{X}] + \text{H}_2\text{O} \longrightarrow [\text{Y}] + \text{H}_2$
 Regarding [X] and [Y] the wrong statement is
 - [X] is BCl_3 and [Y] is H_3BO_3
 - [X] is B_2H_6 and [Y] is H_3BO_3
 - [X] with air and [Y] on strong heating (red heat) give same compound
 - in [Y], B complete its octet by accepting OH^- from water molecule.
- Borax dissolves in water to give
 - acidic solution
 - neutral solution
 - alkaline solution
 - none of these
- Thallium shows lower oxidation state because
 - of its high reactivity
 - of inert pair of electrons
 - of its amphoteric nature
 - it is a transition metal.
- Al and Ga have nearly the same covalent radii because of
 - greater shielding effect of *s* electrons of Ga atoms
 - poor shielding effect of *s* electrons of Ga atoms
 - poor shielding effect of *d* electrons of Ga atoms

(d) greater shielding effect of d electrons of Ga atoms.

12. The element that does not show catenation is
(a) Sn (b) Ge (c) Si (d) Pb

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. **Assertion :** In water, orthoboric acid behaves as a weak monobasic acid.

Reason : In water, orthoboric acid acts as a proton donor.

14. **Assertion :** SiCl_4 forms $[\text{SiCl}_6]^{2-}$ while CCl_4 does not form $[\text{CCl}_6]^{2-}$.

Reason : Carbon shows a fixed covalency of 4 but silicon can expand its covalency from 4 to 6.

15. **Assertion :** Carbon monoxide acts as a powerful reducing agent.

Reason : CO can be easily oxidised to CO_2 .

JEE MAIN / JEE ADVANCED

Only One Option Correct Type

16. Which of the following statements about diborane is correct?

- (I) It contains two 3-centre-2-electron bonds.
(II) The B atoms in it are sp^3 -hybridised.
(III) The molecule is non-planar.
(IV) All B—H bond lengths are equal due to resonance.

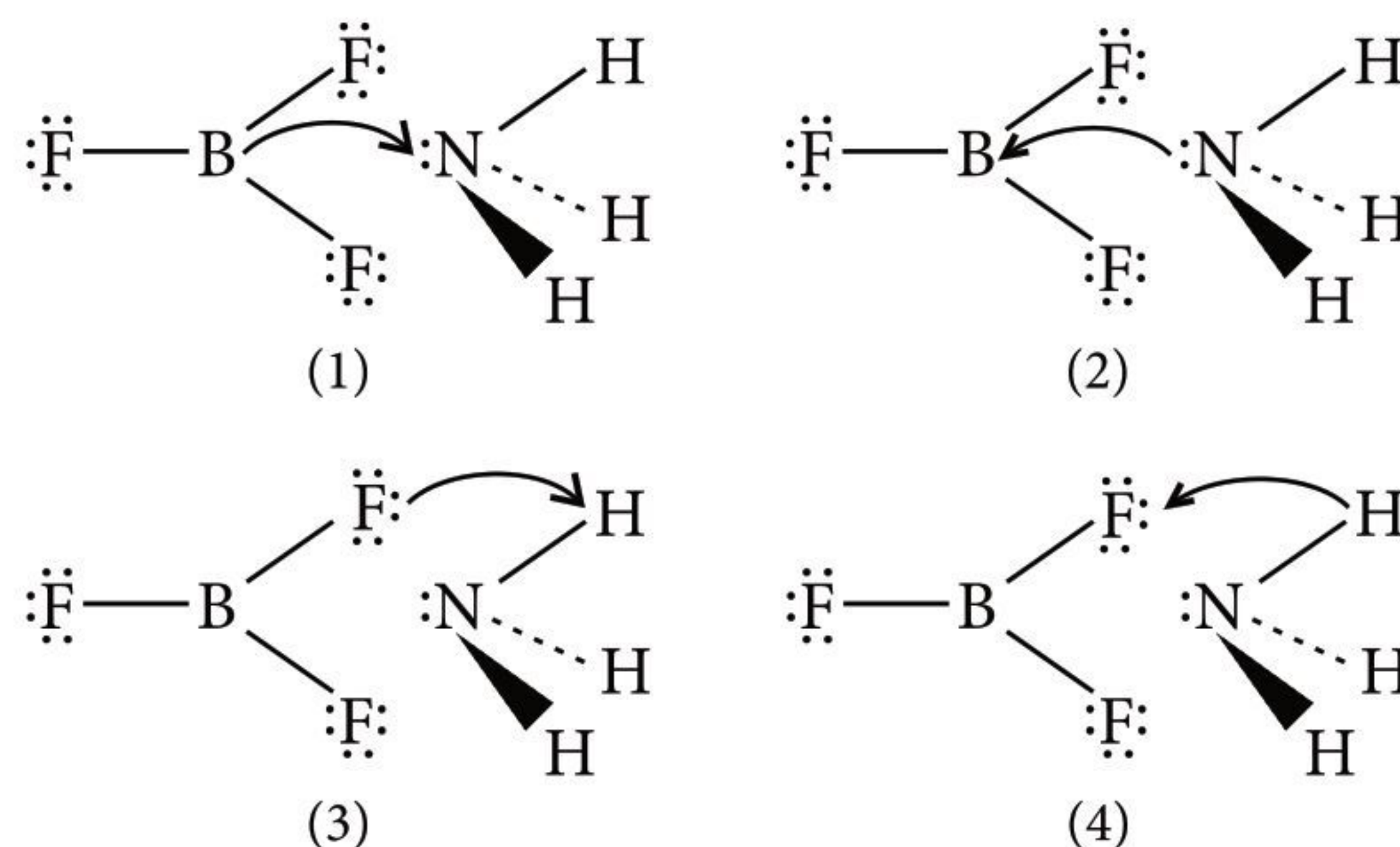
- (a) I, II and III (b) II, III and IV
(c) II and III (d) I and IV

17. Which of the following statements are incorrect?

- (I) Graphite has such a high thermodynamic stability that diamond spontaneously changes into graphite in ordinary conditions.
(II) Graphite and diamond have equal thermodynamic stability.
(III) Graphite is thermodynamically more stable than diamond.
(IV) Diamond is thermodynamically more stable than graphite.

- (a) II, IV (b) I, II and IV
(c) I, II and III (d) II, III, and IV

18. BF_3 and NH_3 undergo a Lewis acid-base reaction forming an adduct. Which picture below correctly represents the curved arrow notation for the initial Lewis acid-Lewis base interaction in this reaction, what is the Lewis acid and the Lewis base?

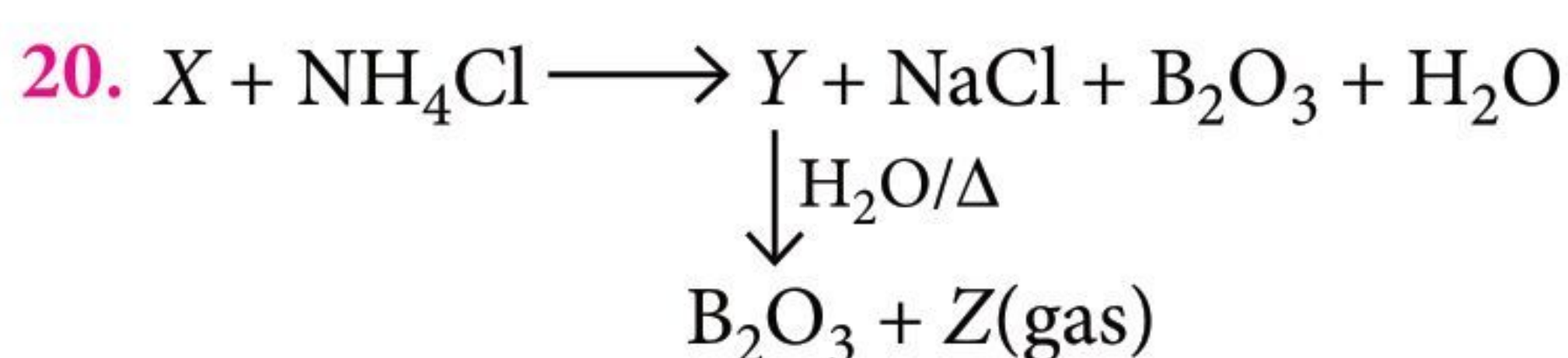


- (a) Picture (1) is correct; NH_3 is the Lewis acid and BF_3 is the Lewis base.
(b) Picture (2) is correct; BF_3 is the Lewis acid and NH_3 is the Lewis base.
(c) Picture (3) is correct; NH_3 is the Lewis acid and BF_3 is the Lewis base.
(d) Picture (4) is correct; BF_3 is the Lewis acid and NH_3 is the Lewis base.

19. $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ is correctly represented as

- (a) $2\text{NaBO}_2 \cdot \text{Na}_2\text{B}_2\text{O}_3 \cdot 10\text{H}_2\text{O}$
(b) $\text{Na}_2[\text{B}_4\text{O}_5(\text{OH})_4] \cdot 8\text{H}_2\text{O}$
(c) $\text{Na}_2[\text{B}_4(\text{H}_2\text{O})_4\text{O}_7] \cdot 6\text{H}_2\text{O}$
(d) all of these.

More than One Options Correct Type



Which of the following statements is/are correct about the above reactions?

- (a) Y has layered structure like graphite.
(b) When Y is heated in steam, it gets decomposed to yield Z gas.
(c) Gas Z is basic in nature.
(d) X has two tetrahedral and two triangular units.

21. Which of the following statements is/are correct regarding the compounds of carbon family elements?

- (a) Maximum coordination number of carbon in commonly occurring compounds is 4, whereas that of silicon is 6.
(b) The stability order of group-14 dihalides is $\text{SiX}_2 < \text{GeX}_2 < \text{SnX}_2 < \text{PbX}_2$.
(c) The order of boiling point of hydrides of group-14 element is $\text{CH}_4 < \text{SiH}_4 < \text{GeH}_4 < \text{SnH}_4$.

(d) MeSiCl_3 on hydrolysis and subsequent condensation will produce $(\text{Me})\text{Si}(\text{OH})_3$.

22. Aluminium becomes passive in

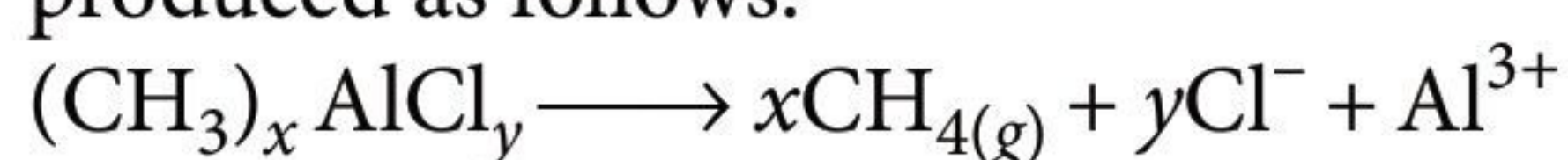
- (a) conc. HNO_3 (b) H_2CrO_4
(c) HClO_4 (d) conc. HCl

23. Which of the following are true about silicones?

- (a) They are formed by hydrolysis of R_2SiCl_2 .
(b) They are polymer, made up of R_2SiO_2 units.
(c) They are made up of SiO_4^{4-} units.
(d) They are macromolecules.

Integer / Numerical Value Type

24. When $(\text{CH}_3)_x\text{AlCl}_y$ is ignited CH_4 , Cl^- and Al^{3+} are produced as follows:



The ignition of 0.643 g of $(\text{CH}_3)_x\text{AlCl}_y$ yields 1.39×10^{-2} moles of $\text{CH}_{4(g)}$. The resulting solution on reaction with excess AgNO_3 yields 6.64×10^{-3} moles of $\text{AgCl}_{(s)}$.

The minimum molecular mass of $(\text{CH}_3)_x\text{AlCl}_y$ is _____.

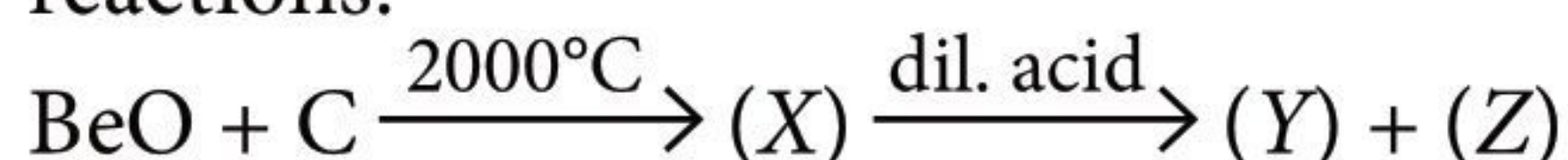
25. Number of π -bonds between two carbon atoms in CaC_2 is _____.

26. Diborane reacts with ammonia to form an adduct which on heating at 473 K decomposes to give a volatile compound called borazine. The number of π -bonds in borazine is _____.

Comprehension Type

Solid compounds of carbon with elements other than hydrogen are generally called carbides. Carbides are of three types : (i) ionic or salt like carbides, (ii) interstitial carbides, formed by transition metals in which carbon atoms occupy tetrahedral holes in the closed packed arrays of metal atoms, these are generally very hard and very high melting solids, (iii) covalent carbides, these are formed by metalloids like Si, B, etc.

27. Identify (X) to (Z) in the following sequence of reactions.



(a) $(\text{X}) = \text{Be}_2\text{C}$, $(\text{Y}) = \text{Be}(\text{OH})_2$, $(\text{Z}) = \text{C}_2\text{H}_4$

(b) $(\text{X}) = \text{BeC}_2$, $(\text{Y}) = \text{Be}(\text{OH})_2$, $(\text{Z}) = \text{CH}_4$

(c) $(\text{X}) = \text{Be}_2\text{C}$, $(\text{Y}) = \text{Be}(\text{OH})_2$, $(\text{Z}) = \text{CH}_4$

(d) $(\text{X}) = \text{BeC}$, $(\text{Y}) = \text{Be}(\text{OH})_2$, $(\text{Z}) = \text{CH}_4$

28. Which carbide is produced when a mixture of sand, carbon, common salt and saw dust is strongly heated in electric furnace?

- (a) Diamond (b) Carborundum
(c) Graphite (d) Coal

Matrix Match Type

29. Match the following and select the correct answer using the code given below :

Column I

- (A) Acidic
(B) Neutral
(C) Amphoteric
(D) Basic

Column II

- p. SiO_2
q. B_2O_3
r. Al_2O_3
s. CO
t. Ti_2O_3
u. Ga_2O_3

Codes :

- | | A | B | C | D |
|-----|-----|-----|-----|---|
| (a) | p | q,r | s,t | u |
| (b) | p,q | r | s,u | t |
| (c) | r | s | p,u | q |
| (d) | p,q | s | r,u | t |

30. Match the following and select the correct answer using the code given below :

Column I

- (A) Anhydrous AlCl_3
(B) Alum
(C) Ultramarine
(D) Borax

Column II

- (P) Antiseptic
(Q) Alloy
(R) Friedel craft's reaction
(S) Complex blue coloured silicate
(T) Tincal

Codes :

- (a) A-R, B-P, C-S, D-T, E-Q
(b) A-P, B-Q, C-S, D-T, E-R
(c) A-R, B-P, C-T, D-Q, E-S
(d) A-P, B-S, C-T, D-P, E-Q



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No. of questions attempted

No. of questions correct

Marks scored in percentage

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You can score good in the final exam.

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SATISFACTORY !

You need to score more next time.

< 60%

NOT SATISFACTORY!

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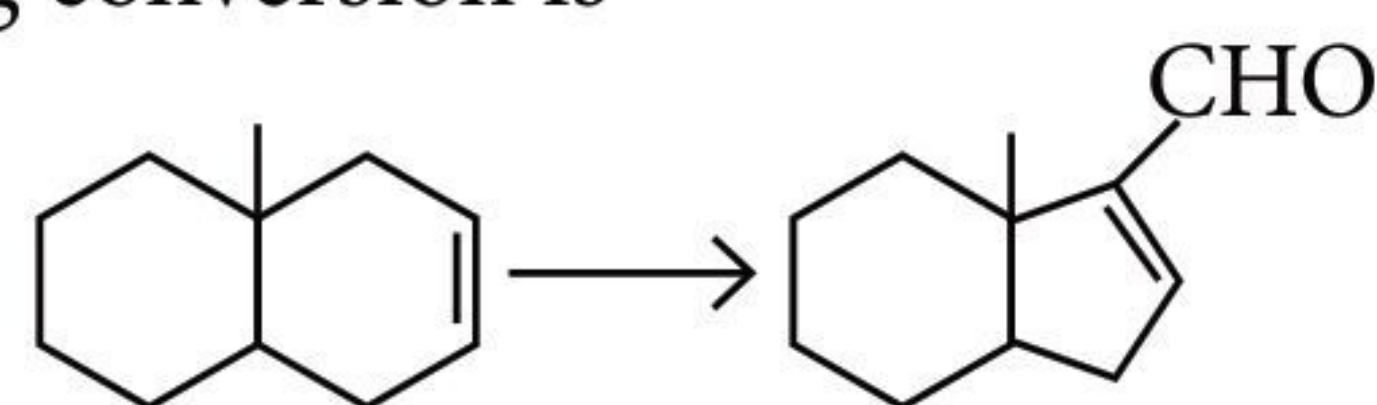
Practicing these MCQs help to strengthen your concepts and give you extra edge in your NEET preparation

1. The coagulation values in millimoles per litre of the electrolytes used for the coagulation of As_2S_3 are given below :

I. $(\text{NaCl}) = 52$, II. $(\text{BaCl}_2) = 0.69$,
III. $(\text{MgSO}_4) = 0.22$

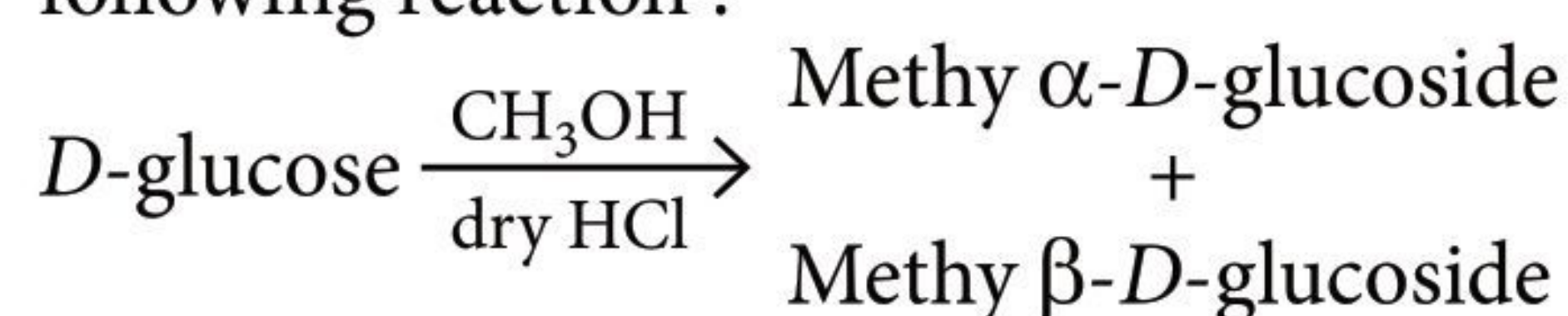
The correct order of their coagulating power is

- (a) $\text{I} > \text{II} > \text{III}$ (b) $\text{II} > \text{I} > \text{III}$
(c) $\text{III} > \text{II} > \text{I}$ (d) $\text{III} > \text{I} > \text{II}$
2. Correct sequence of reagents required for the following conversion is



- (a) $\xrightarrow{\text{O}_3/\text{Zn}, \text{H}_2\text{O}} \xrightarrow{\text{OH}^-} \xrightarrow{\Delta}$
(b) $\xrightarrow{\text{CrO}_3} \xrightarrow{\text{H}^+}$
(c) $\xrightarrow{\text{N}_2\text{H}_4} \xrightarrow{\text{OH}^-} \xrightarrow{\Delta}$
(d) $\xrightarrow{\text{KMnO}_4/\text{H}^+} \xrightarrow{\text{OH}^-}$
3. Given that Λ_{eq}° (in $\text{S cm}^2 \text{eq}^{-1}$) at $T = 298 \text{ K}$, for $\text{Ba}(\text{OH})_2$, BaCl_2 and NH_4Cl are 228.8, 120.3 and 129.8 respectively. Specific conductance for 0.2 N NH_4OH solution is $4.766 \times 10^{-4} \text{ S cm}^{-1}$, then the pH of given NH_4OH solution will be
- (a) 9.2 (b) 11.3 (c) 12.1 (d) 7.9

4. D-glucose, on treating with methanol in presence of dry HCl gives methyl glucoside according to the following reaction :



Mention true (T) and false (F) from the following statements :

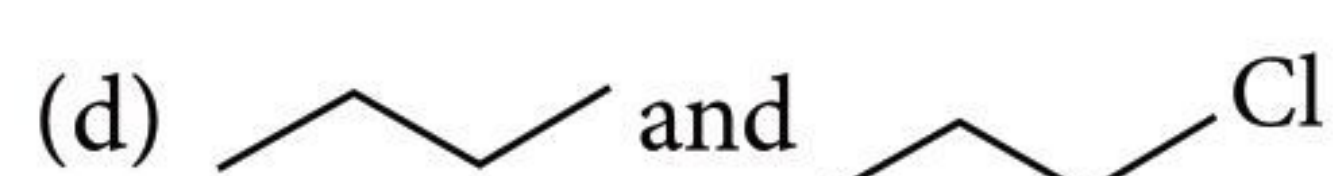
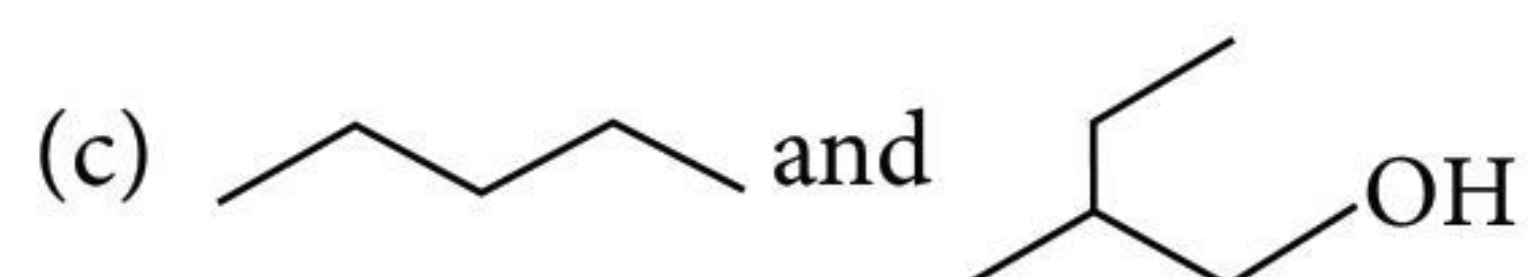
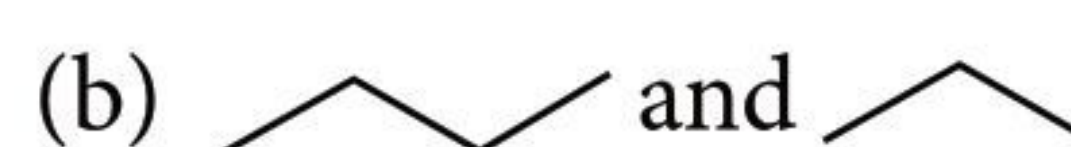
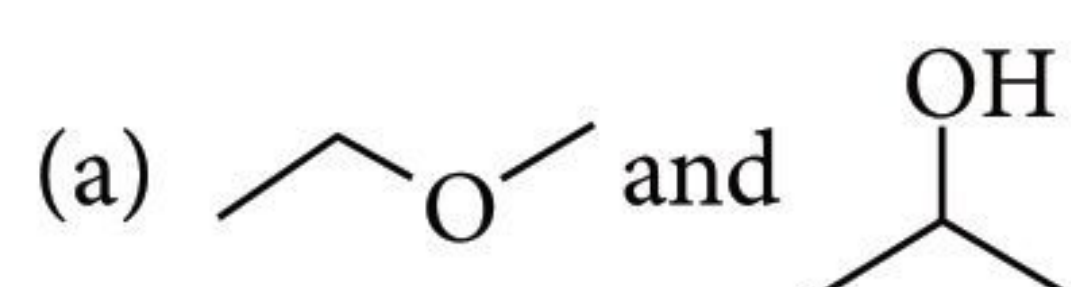
- S_1 : The glucosides do not reduce Fehling's solution.
 S_2 : The glucosides do not react with hydrogen cyanide or hydroxylamine.
 S_3 : Behaviour of glucosides as stated in S_1 and S_2 indicates the absence of free $-\text{CHO}$ group.
 S_4 : The two forms of glucosides are enantiomers.

- (a) TTFF (b) FTTT (c) TTTF (d) TFTF
5. The temperature of blast furnace to produce iron from its ore, Fe_2O_3 varies from 500°C at the top of the furnace to about 1900°C at the bottom of the furnace. The reaction between the ore Fe_2O_3 and CO at the lowest temperature ($\sim 500^\circ\text{C}$) is
- (a) $3\text{Fe}_2\text{O}_3 + \text{CO} \rightarrow 2\text{Fe}_3\text{O}_4 + \text{CO}_2$
(b) $\text{Fe}_2\text{O}_3 + \text{CO} \rightarrow 2\text{FeO} + \text{CO}_2$
(c) $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$
(d) $\text{Fe}_2\text{O}_3 + \text{CO} + \text{CaCO}_3 \rightarrow 2\text{FeO} + 2\text{CO}_2 + \text{CaO}$

6. If a is the length of the side of a cube, the distance between the body-centred atom and one corner atom in the cube will be

(a) $\frac{2}{\sqrt{3}}a$ (b) $\frac{4}{\sqrt{3}}a$ (c) $\frac{\sqrt{3}}{4}a$ (d) $\frac{\sqrt{3}}{2}a$

7. In which of the following pairs first has higher melting point than second?



8. Identify the correct sequence of increasing number of π -bonds in structures of the following molecules.

I. $\text{H}_2\text{S}_2\text{O}_6$ II. H_2SO_3 III. $\text{H}_2\text{S}_2\text{O}_5$

(a) I, II, III (b) II, III, I
(c) II, I, III (d) I, III, II

9. Which one of the following ions exhibits $d-d$ transition and paramagnetism as well?

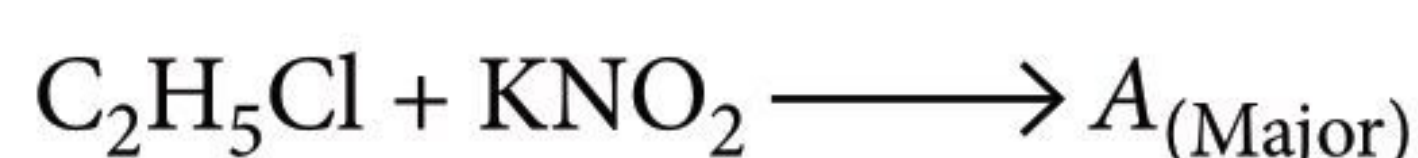
(a) CrO_4^{2-} (b) $\text{Cr}_2\text{O}_7^{2-}$
(c) MnO_4^- (d) MnO_4^{2-}

10. For the reaction, $2\text{NO}_2 \rightarrow \text{N}_2\text{O}_2 + \text{O}_2$, rate expression is as follows: $\frac{d[\text{NO}_2]}{dt} = k[\text{NO}_2]^n$, where,

$k = 3 \times 10^{-3} \text{ mol}^{-1} \text{ L sec}^{-1}$. If the rate of formation of oxygen is $1.5 \times 10^{-4} \text{ mol L}^{-1} \text{ sec}^{-1}$, then the molar concentration of NO_2 in mol L^{-1} is

(a) 1.5×10^{-4} (b) 0.0151
(c) 0.214 (d) 0.316

11. In the following reaction,

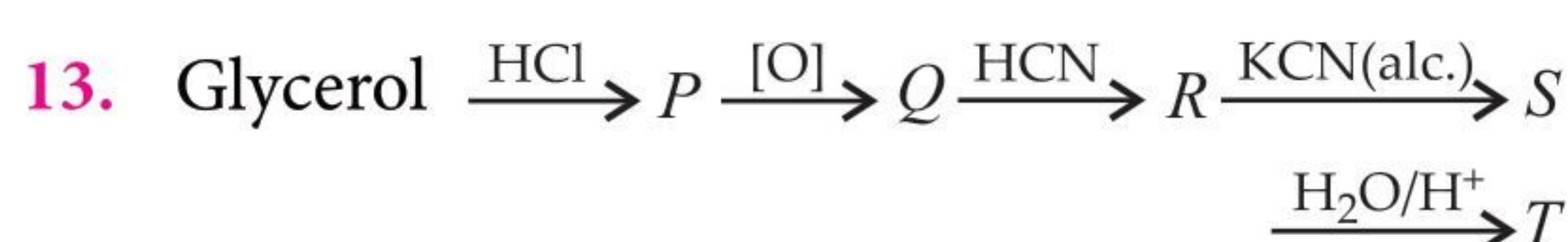


The bond absent in 'A' is

(a) C—N (b) C—O
(c) C—H (d) C—C

12. Which of the following compounds possesses highest value of molar conductance at infinite dilution?

(a) $[\text{Pt}(\text{NH}_3)_5\text{Cl}]\text{Cl}_3$ (b) $[\text{Pt}(\text{NH}_3)_3\text{Cl}_3]\text{Cl}$
(c) $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}_2$ (d) $[\text{Pt}(\text{NH}_3)_6]\text{Cl}_4$



'T' is

(a) citric acid (b) ascorbic acid
(c) tartaric acid (d) saccharic acid.

14. Which one of the following is an antihistamine?

(a) Iproniazid (b) Salvarsan
(c) Seldane (d) Chloramphenicol

15. Which of the following amide does not undergo Hoffmann's degradation?

1. Propionamide
2. *N*-methyl butanamide
3. Butanamide
4. *N,N*-dimethyl butanamide

(a) 4 only (b) 3 only
(c) 3 and 4 (d) 2 and 4

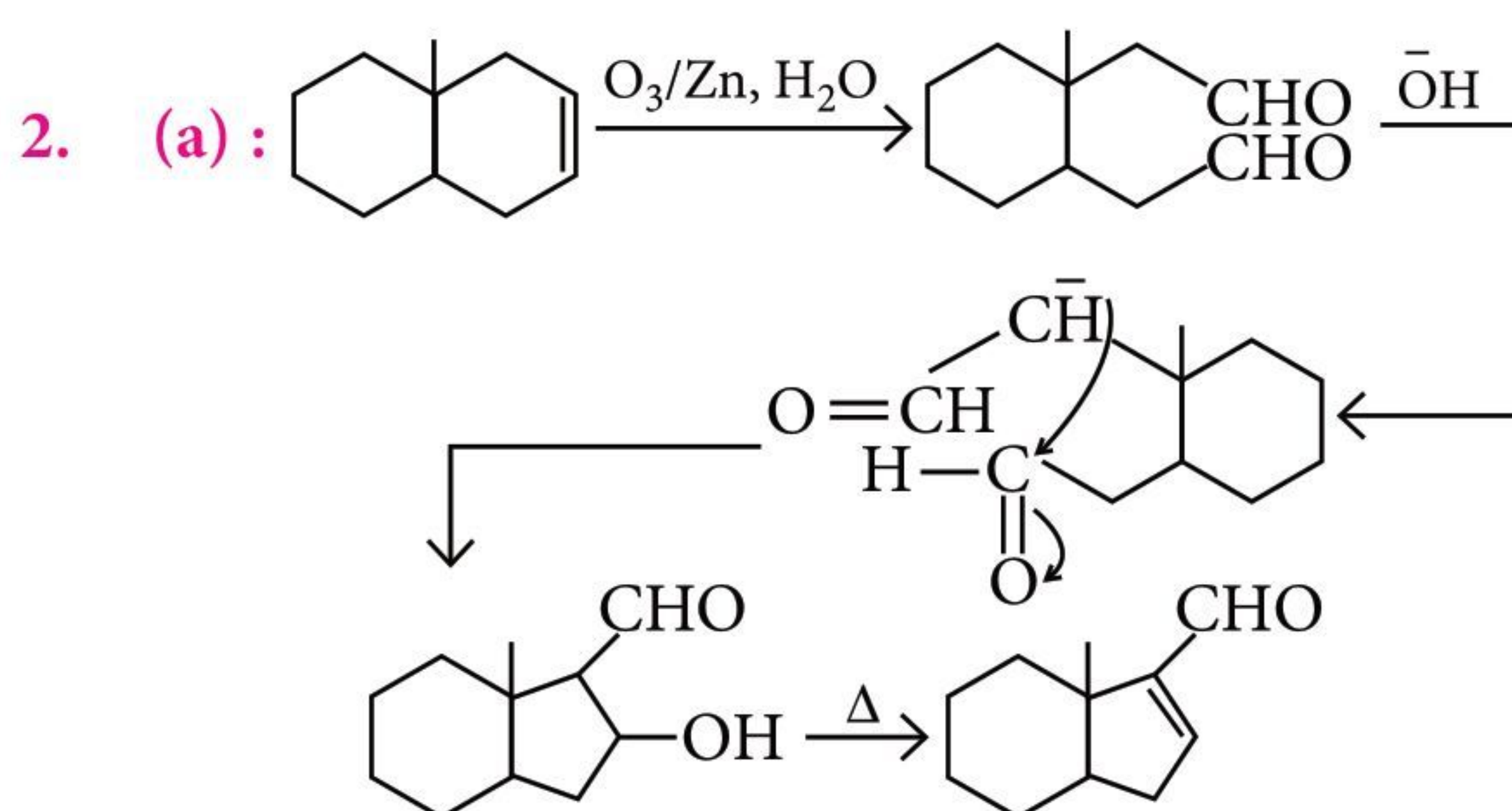
SOLUTIONS

1. (c) : Coagulating power $\propto \frac{1}{\text{Coagulation value}}$

Lower the coagulation value, higher is the coagulating power so, the correct order is :



(III) (II) (I)



3. (b) : $\Lambda_{eq}^\circ (\text{Ba}(\text{OH})_2) = \lambda_{\text{Ba}^{2+}}^\circ + \lambda_{\text{OH}^-}^\circ \dots \text{(i)}$

$$\Lambda_{eq}^\circ (\text{BaCl}_2) = \lambda_{\text{Ba}^{2+}}^\circ + \lambda_{\text{Cl}^-}^\circ \dots \text{(ii)}$$

$$\Lambda_{eq}^\circ (\text{NH}_4\text{Cl}) = \lambda_{\text{NH}_4^+}^\circ + \lambda_{\text{Cl}^-}^\circ \dots \text{(iii)}$$

$$\Lambda_{eq}^\circ (\text{NH}_4\text{OH}) = \lambda_{\text{NH}_4^+}^\circ + \lambda_{\text{OH}^-}^\circ$$

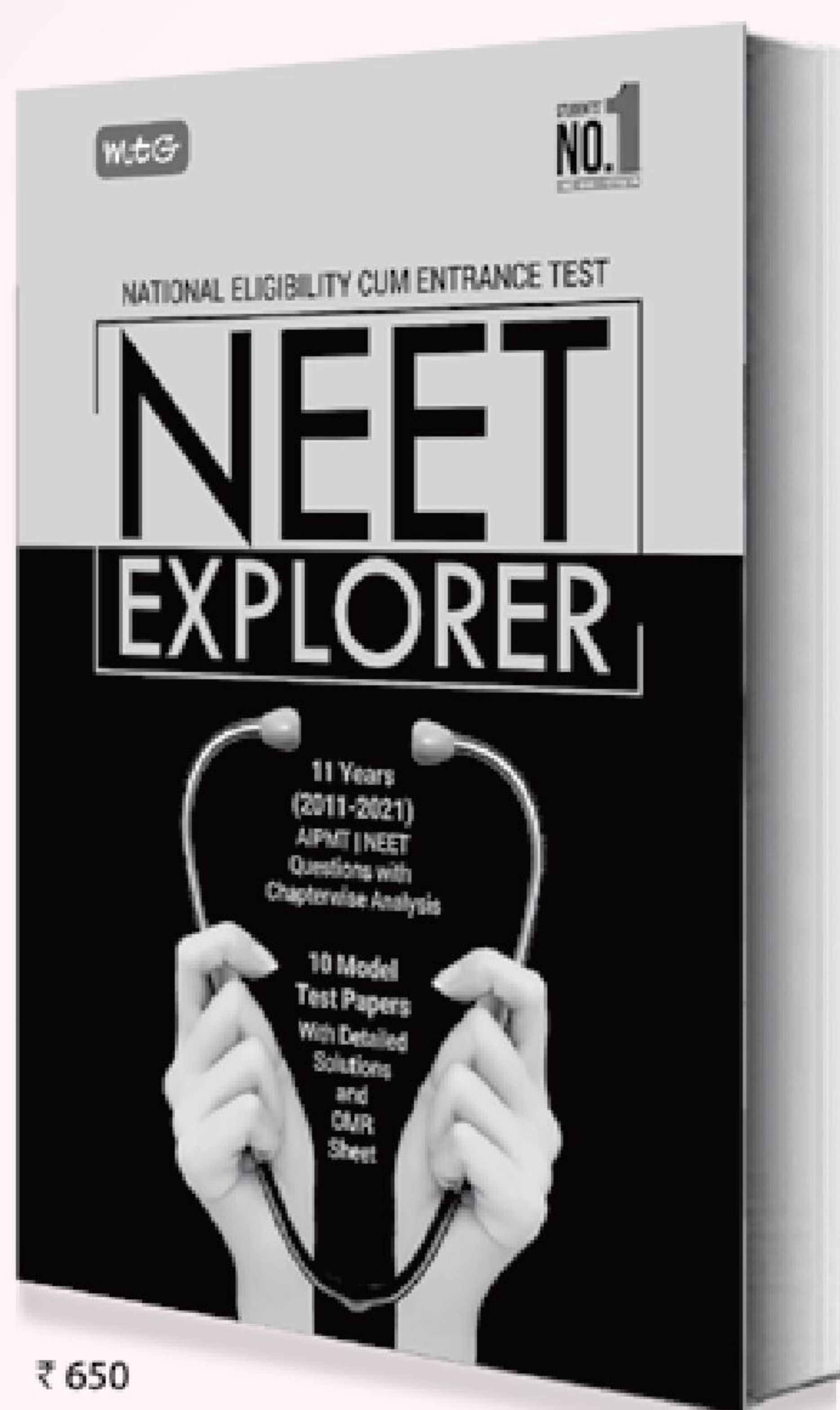
eq. (i) + eq. (iii) – eq. (ii), we get

$$= 228.8 + 129.8 - 120.3 = 238.3 \text{ S cm}^2 \text{ eq}^{-1}$$

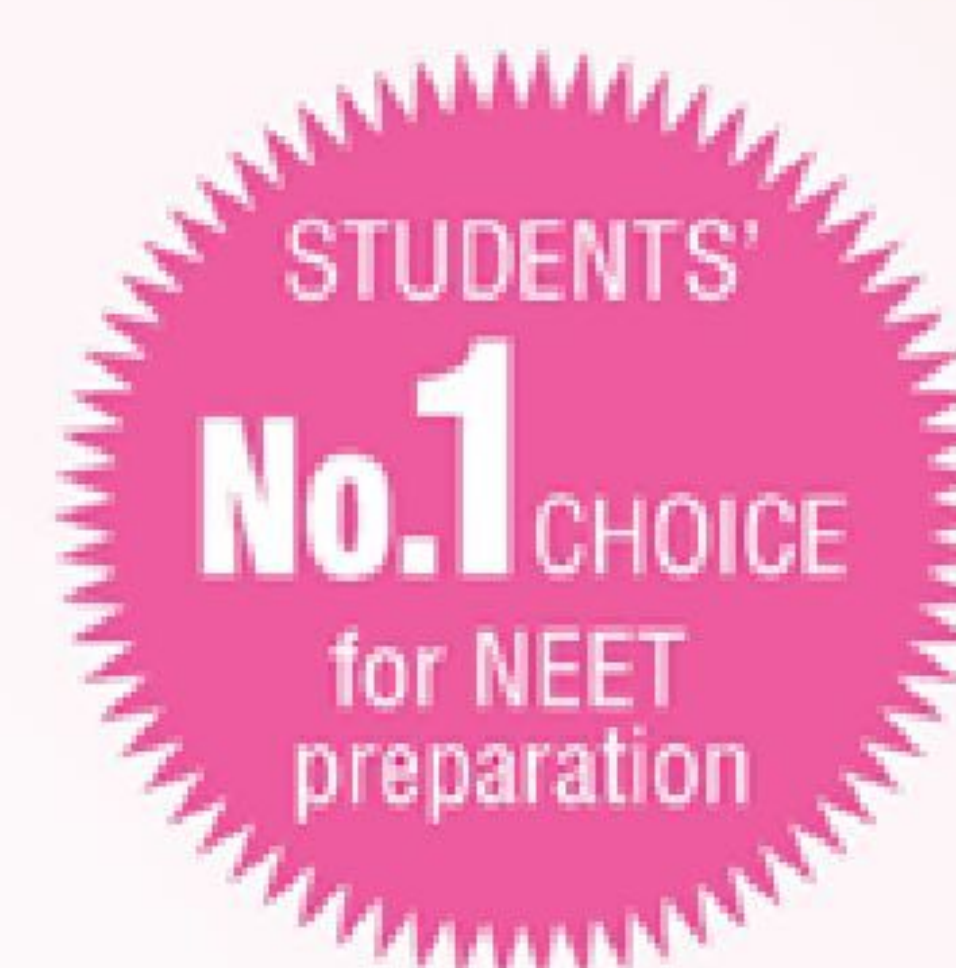
Now, major conductivity of NH_4OH ,

$$\Lambda_{eq} = \kappa \times \frac{1000}{\text{Normality}} = \frac{4.766 \times 10^{-4} \times 1000}{0.2} = 2.383$$

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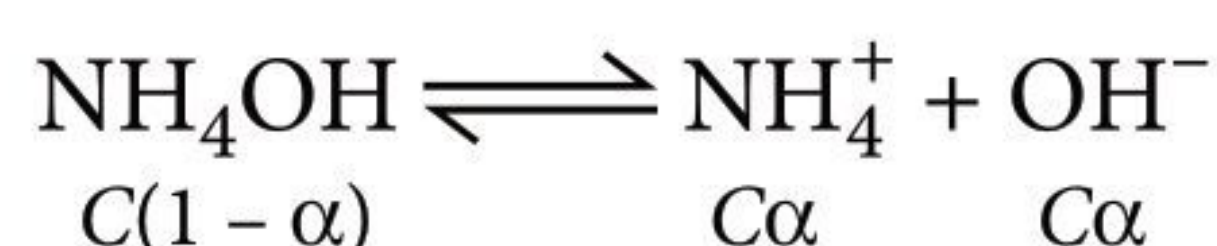


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$$\alpha = \frac{\Lambda_{eq}(\text{NH}_4\text{OH})}{\Lambda_{eq}^\circ(\text{NH}_4\text{OH})} = \frac{2.383}{238.3} = 0.01$$



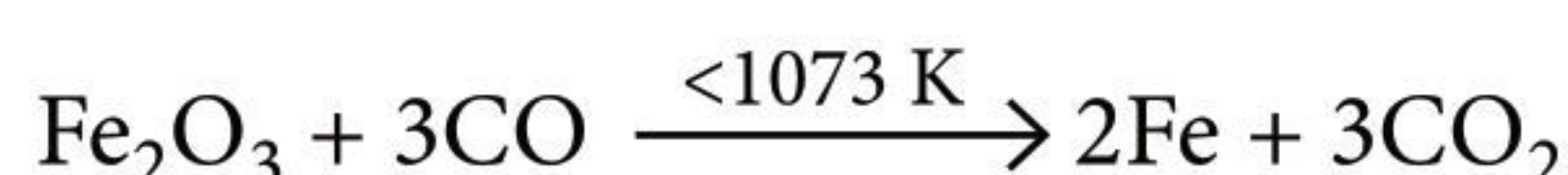
$$[\text{OH}^-] = 0.2 \times 0.01 = 2.0 \times 10^{-3} \text{ N}$$

$$\text{pOH} = 3 - \log 2 = 3 - 0.3010 = 2.7$$

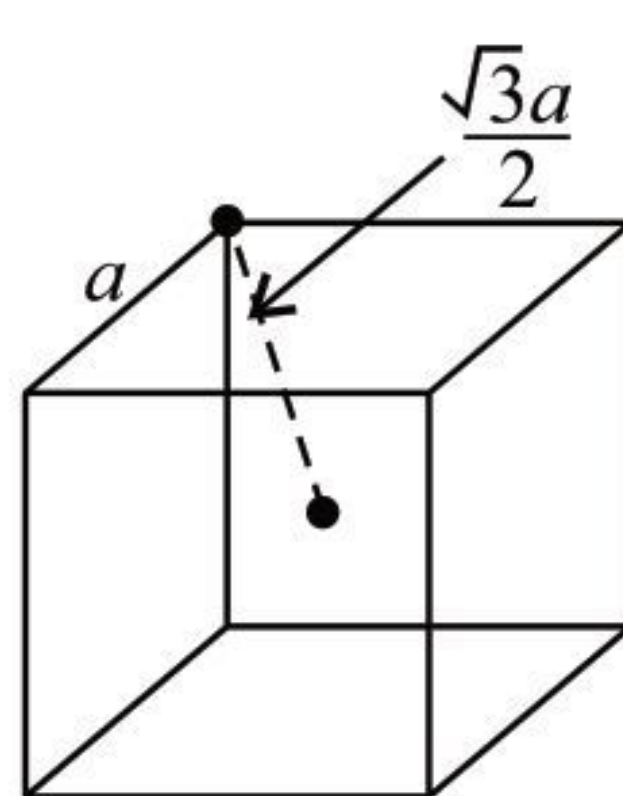
$$\text{pH} = 14 - 2.7 = 11.3$$

4. (c) : S₁, S₂ and S₃ are true but S₄ is false because the glycosides are not mirror images of each other.

5. (c) : The reaction at 500 °C is

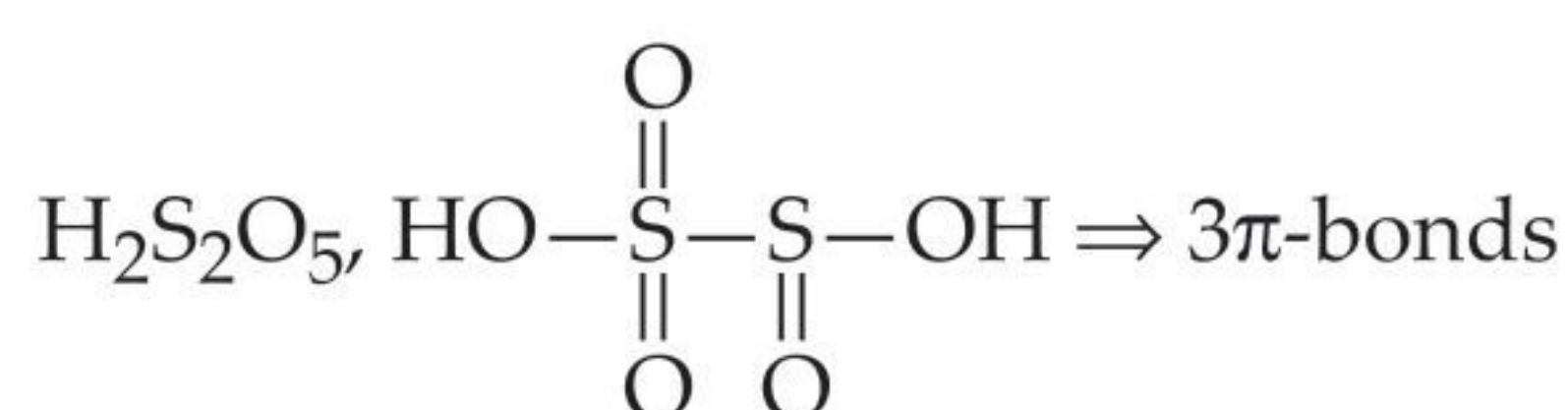


6. (d) : The distance between the body-centred atom and one corner atom is $\frac{\sqrt{3}a}{2}$ i.e. half of the body diagonal.



7. (b) : In (b), first compound has high molecular mass than second. So, first has higher melting point.

8. (b) : $\text{H}_2\text{S}_2\text{O}_6$, $\text{HO}-\overset{\text{O}}{\parallel}\text{S}-\overset{\text{O}}{\parallel}\text{S}-\text{OH} \Rightarrow 4\pi\text{-bonds}$



9. (d) : In CrO_4^{2-} Cr^{+6} ($n = 0$) diamagnetic
 In $\text{Cr}_2\text{O}_7^{2-}$ Cr^{+6} ($n = 0$) diamagnetic
 In MnO_4^- Mn^{+7} ($n = 0$) diamagnetic
 In MnO_4^{2-} Mn^{+6} ($n = 1$) paramagnetic
 In MnO_4^{2-} , one unpaired electron(n) is present in d -orbital so, d - d transition is possible.

10. (d) : From the unit of k , it is evident that it is a second order reaction.

$$-\frac{1}{2} \frac{d[\text{NO}_2]}{dt} = \frac{d[\text{O}_2]}{dt}$$

$$\therefore -\frac{d[\text{NO}_2]}{dt} = 2 \times \frac{d[\text{O}_2]}{dt}$$

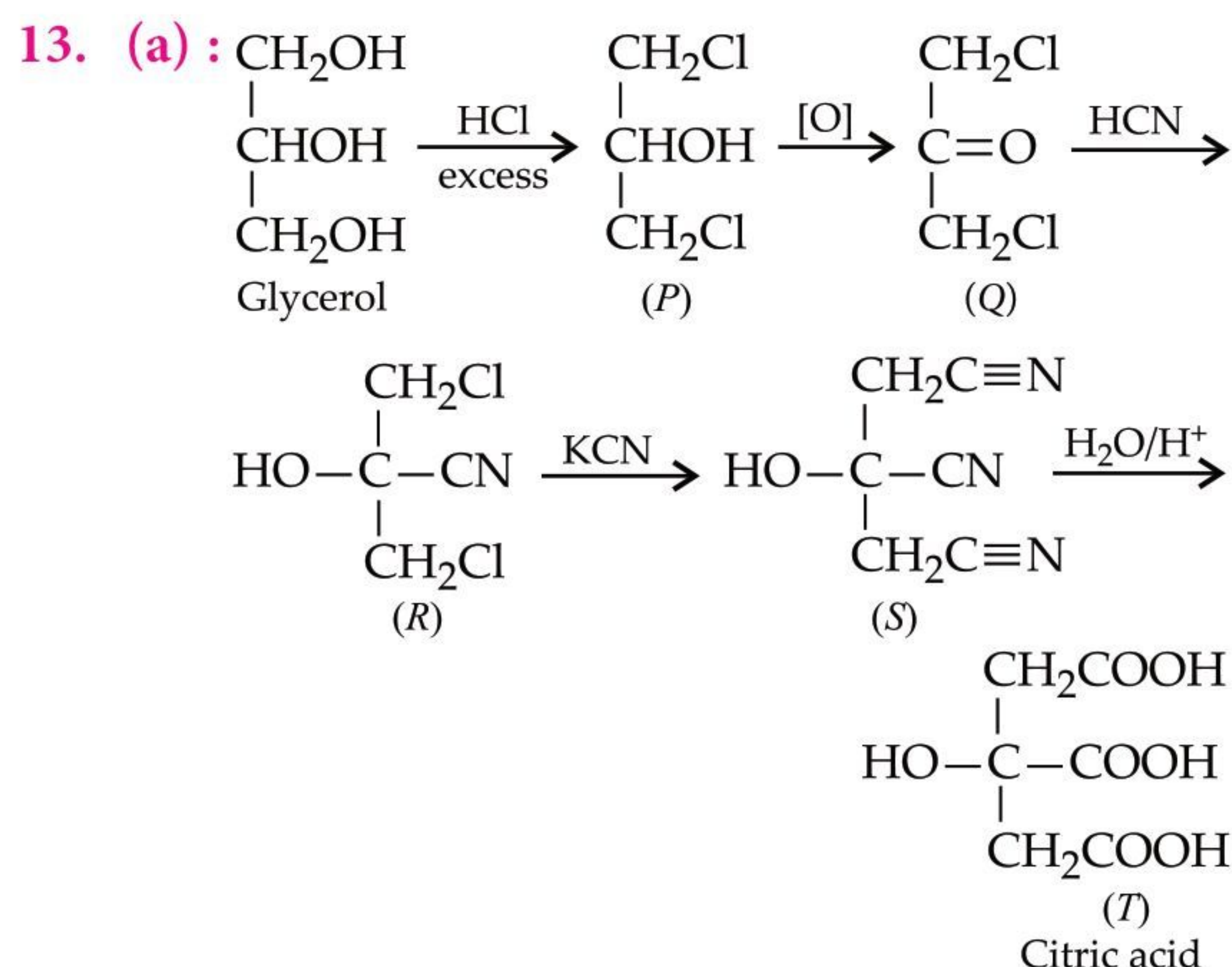
$$= 2 \times 1.5 \times 10^{-4} = 3 \times 10^{-4}$$

$$3 \times 10^{-4} = k[\text{NO}_2]^2 = 3 \times 10^{-3}[\text{NO}_2]^2$$

$$\therefore [\text{NO}_2] = 0.316 \text{ mol L}^{-1}$$

11. (a) : $\text{C}_2\text{H}_5\text{Cl} + \text{KNO}_2 \longrightarrow \text{C}_2\text{H}_5\text{ONO} + \text{KCl}$

12. (d)



14. (c) : Iproniazid \rightarrow Tranquilizer
 Salvarsan \rightarrow Antimicrobial
 Terfenadine (Seldane) \rightarrow Antihistamine
 Chloramphenicol \rightarrow Antibiotic

15. (d) : Hoffmann bromamide degradation is shown by $\text{R}-\text{CO}-\text{NH}_2$ type amides.



COMIC CAPSULE



If Iron Man and Silver Surfer teamed up, they'd be alloys!

BRUSH UP *for* NEET/JEE

CLASS-XII

Brush up your concepts to get high rank in NEET/JEE (Main and Advanced) by reading this column. This specially designed column is updated year after year by a panel of highly qualified teaching experts well-tuned to the requirements of these Entrance Tests.

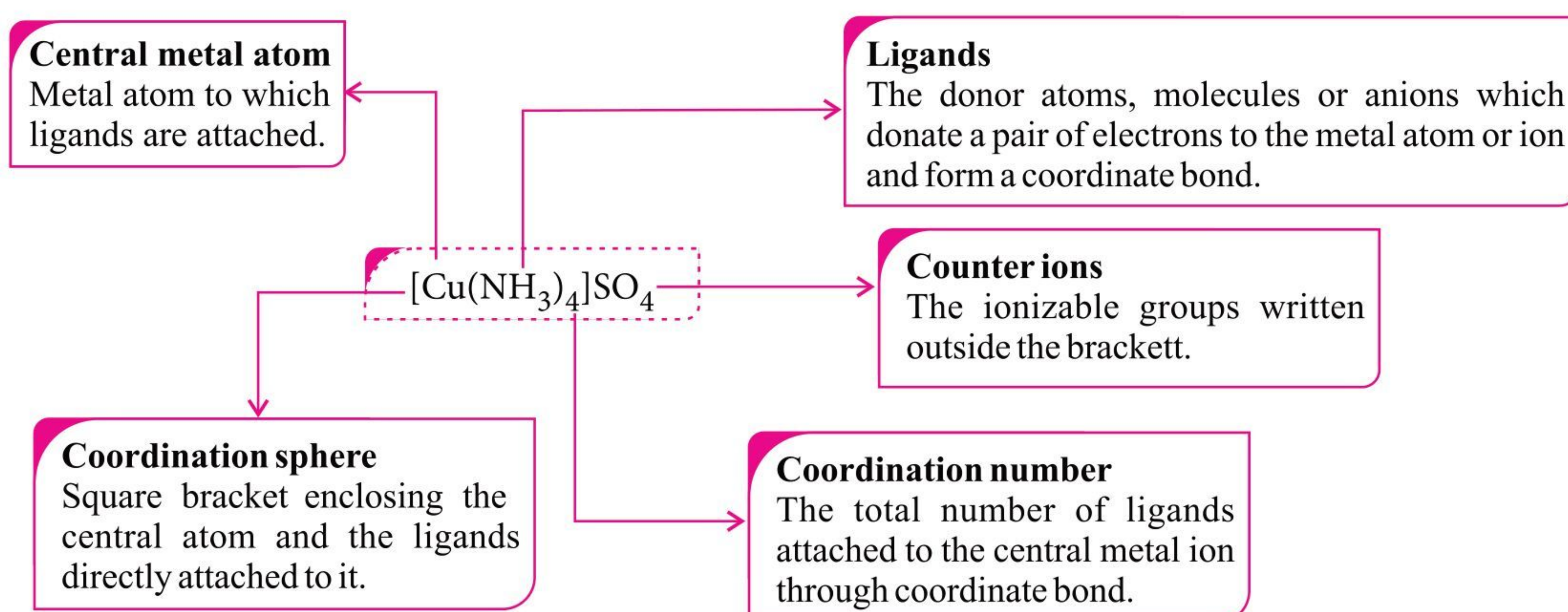
Unit
5

Coordination Compounds

- Coordination compounds are those in which a central metal atom or ion is attached with a fixed number of groups or molecules (ligands) through coordinate bonds.
- Differences between Double Salts and Coordination Compounds :

Double Salts	Coordination Compounds
1. These exist only in solid state and dissociate into constituent species in their solution.	1. They retain their identity in solid as well as in solution state.
2. They lose their identity in dissolved state.	2. They do not lose their identity in dissolved state.
3. Their properties are essentially the same as those of their constituent species.	3. Their properties are different from those of their constituents. For example, $K_4[Fe(CN)_6]$ does not show the test of Fe^{2+} and CN^- ions.
4. In double salts' the metal atom/ion exhibit normal valency.	4. In coordination compounds, the number of negative ions or molecules surrounding the central metal atom is different from its normal valency.

TERMS RELATED TO COORDINATION COMPOUNDS



Mono or unidentate ligands : Ligands with one donor site, *e.g.*, F^- , Cl^- , Br^- , H_2O , CN^- , NO_2^- , OH^- , CO , etc.

Bidentate ligands : Ligands which have two donor atoms at two positions, *e.g.*, Ethylenediamine, oxalate, glycine, etc.

Polydentate ligands : The ligands having several donor atoms are called polydentate ligands, *e.g.*, Diethylenetriamine having 3 donor atoms is tridentate, EDTA with 6 donor atoms is hexadentate.

Ligands

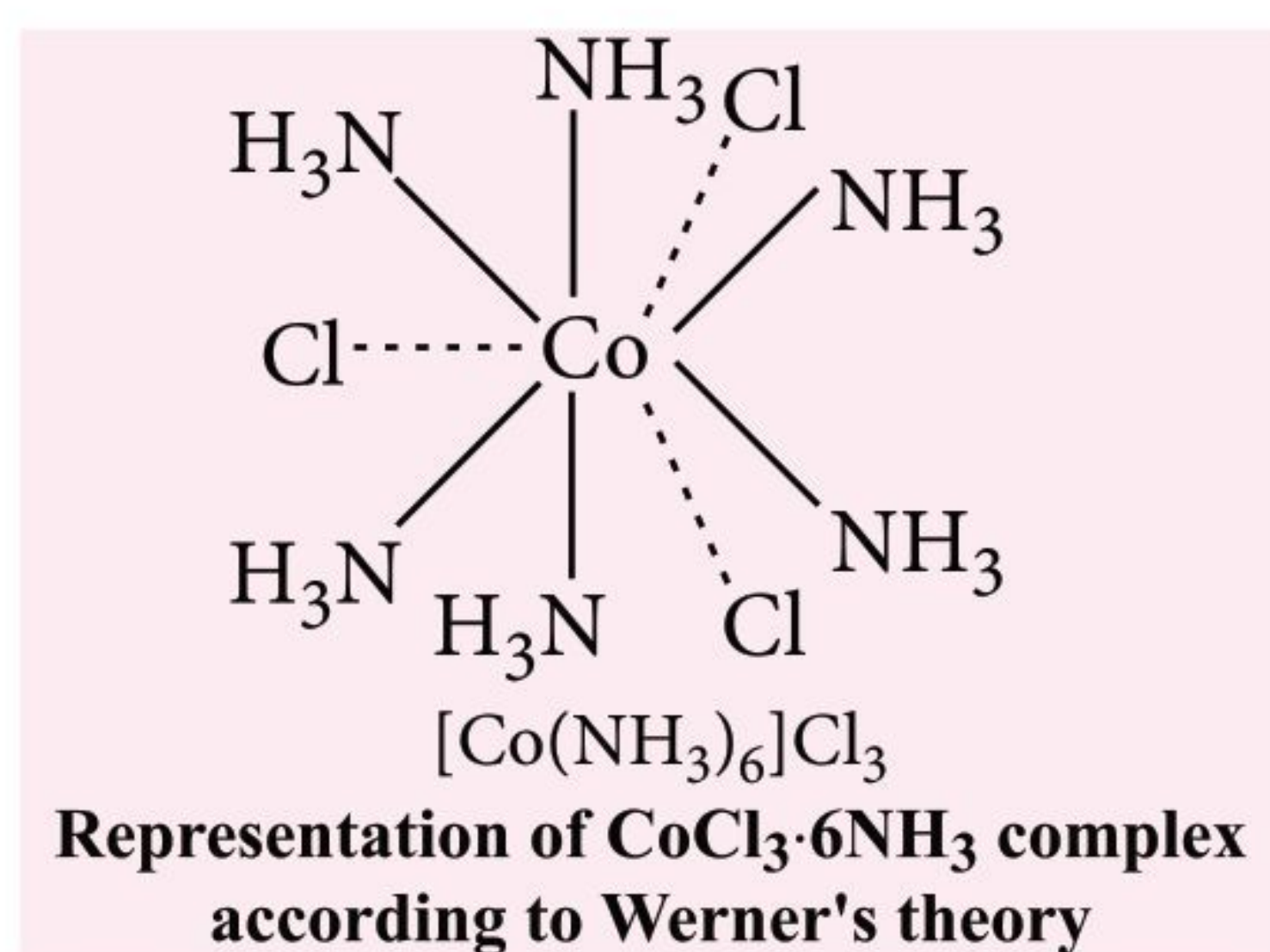
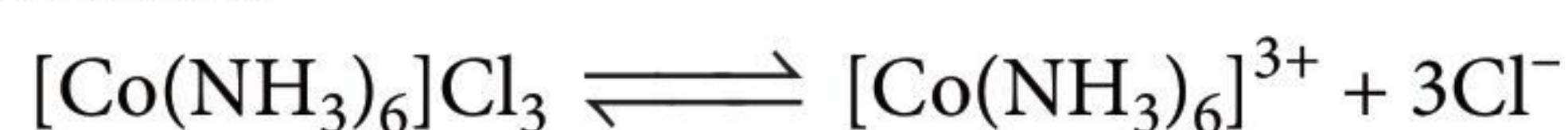
When a polydentate ligand coordinates to a metal ion through more than one electron pair of donor site simultaneously, it is called **chelation**. The resulting complex has ring like structure and such ligand it is called chelating ligand.

Chelating ligands form more stable complexes than similar ordinary complexes, in which the ligands act as monodentate.

Ambidentate ligand : A unidentate ligand which can coordinate through two different atoms, *e.g.*, NO_2^- , SCN^- , etc.

WERNER'S THEORY OF COORDINATION COMPOUNDS

- According to this theory central metal atom shows two types of linkages (valencies) in coordination compounds.
- Primary valency :** Ionisable, corresponds to oxidation state of the central metal atom/ion, satisfied by negative ions, non-directional.
- Secondary valency :** Non-ionisable, corresponds to coordination number of the central metal atom/ion, satisfied by neutral molecules or ligands, fixed for a metal, directional, giving definite geometry to the complex.
- The ionisation of the coordination compound is written as :



IUPAC NOMENCLATURE

Rules for Naming Coordination Compounds

- The cation is named first then the anion.

- In naming coordination sphere, ligands are named first in alphabetical order followed by metal atom and then oxidation state of metal by a roman numeral in parentheses.
- Name of anionic ligands end in *-o*, *e.g.* Cl^- : Chlorido, $C_2O_4^{2-}$: Oxalato etc.
- Neutral ligands (with a few exceptions *e.g.*, H_2O : aqua) retain their names *e.g.*, NH_3 : Ammine etc.
- Name of cationic ligands end in *-ium*, *e.g.*, NO_2^+ : Nitronium etc.
- Certain ligands are represented by abbreviations in parentheses instead of their complex structural formulae, *e.g.*, ethylenediamine (*en*).
- Ambidentate ligands are named by using different names of ligands or by placing the symbol of donor atom, *e.g.*, $-SCN$ (Thiocyanato-S or Thiocyanato), $-NCS$ (Thiocyanato-N or Isothiocyanato), $-ONO$ (Nitrito-O or Nitrito), $-NO_2$ (Nitrito-N or Nitro)

MONTHLY TEST DRIVE CLASS XII

ANSWER

KEY

- | | | | | |
|-----------|-------------|-------------|---------|-----------|
| 1. (a) | 2. (c) | 3. (b) | 4. (b) | 5. (a) |
| 6. (b) | 7. (a) | 8. (c) | 9. (a) | 10. (d) |
| 11. (c) | 12. (c) | 13. (c) | 14. (d) | 15. (b) |
| 16. (c) | 17. (a) | 18. (a) | 19. (b) | 20. (a,b) |
| 21. (a,d) | 22. (a,c,d) | 23. (a,b,c) | 24. (5) | 25. (1) |
| 26. (4) | 27. (b) | 28. (a) | 29. (b) | 30. (d) |

ISOMERISM

ISOMERISM

Structural isomerism

It is displayed by compounds that have different ligands within their coordination sphere.

Ionisation isomerism : Isomers that give different ions in solution, e.g., $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{Cl}$; $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Br}$.

Hydrate isomerism : Isomers having different number of H_2O as a ligand and as water of hydration, e.g., $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$; $[\text{CrCl}(\text{H}_2\text{O})_5]\text{Cl}_2 \cdot \text{H}_2\text{O}$, $[\text{CrCl}_2(\text{H}_2\text{O})_4]\text{Cl} \cdot 2\text{H}_2\text{O}$.

Coordination isomerism : The ligands are interchanged in both the cationic and anionic ions, e.g., $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{CN})_6]$; $[\text{Cr}(\text{NH}_3)_6][\text{Co}(\text{CN})_6]$

Linkage isomerism : This type of isomerism exists when ambidentate ligand is coordinated with its different donor atoms, e.g., $[\text{Co}(\text{NH}_3)_5\text{ONO}]\text{Cl}_2$; $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$.

Stereoisomerism

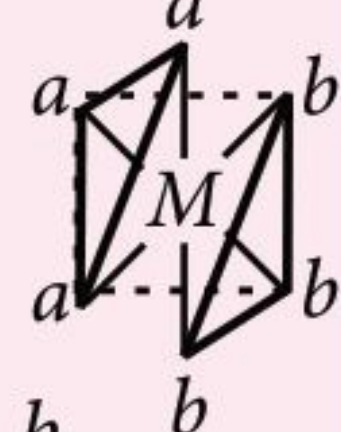
Shown by compounds having same structural formula but differ only in the spatial arrangement of ligands around the central atom.

Geometrical isomerism

Arises due to different possible geometric arrangement of ligands.

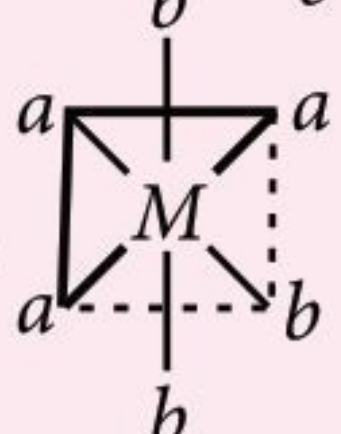
In octahedral complex $[\text{Ma}_3\text{b}_3]$

Facial (fac) : 3 donor atoms of same ligands occupy adjacent positions at the corners.

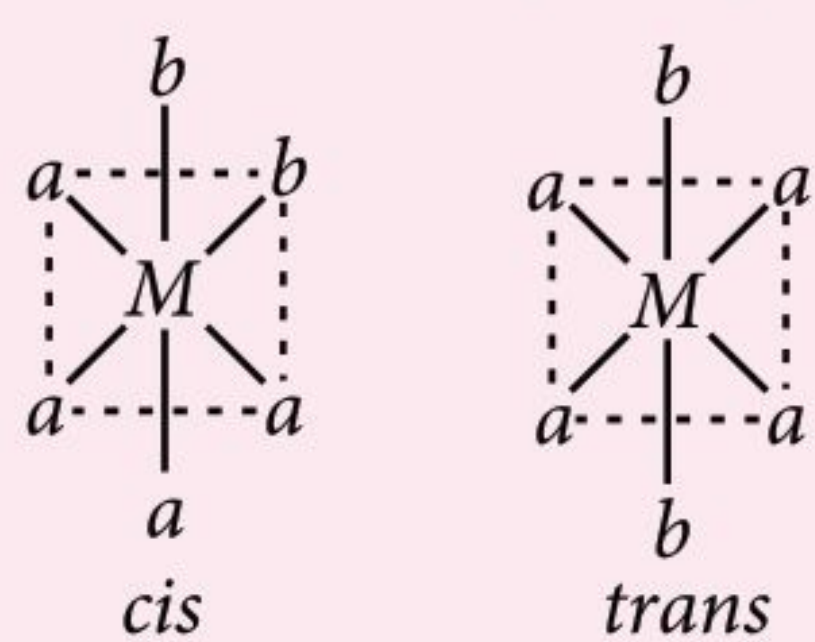


Meridional (mer) :

When the positions are around the meridian.

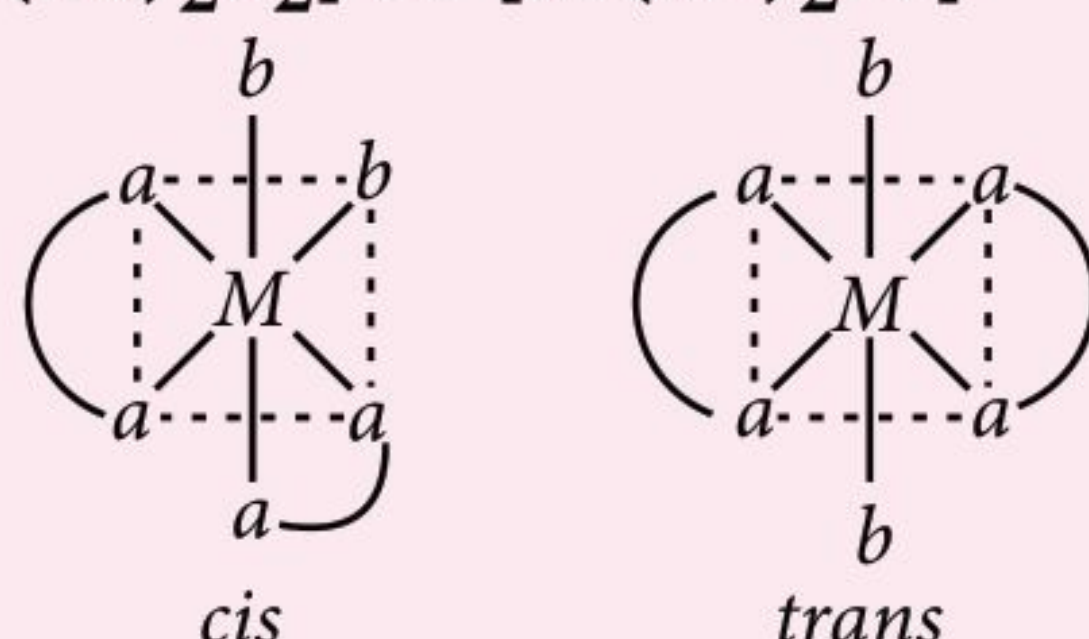


In octahedral complex $[\text{Ma}_4\text{b}_2]$



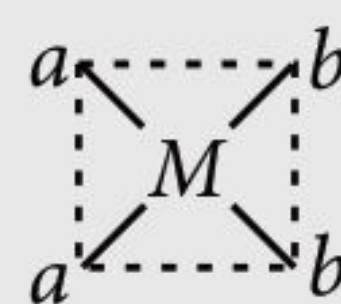
In octahedral complex

$[\text{M}(\text{aa})_2\text{b}_2]$ or $[\text{M}(\text{aa})_2\text{bc}]$

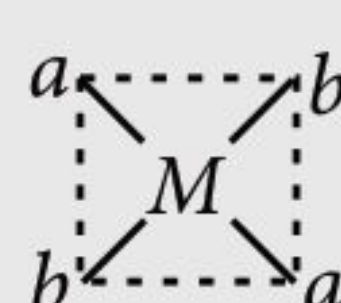


In square planar complex $[\text{Ma}_2\text{b}_2]$

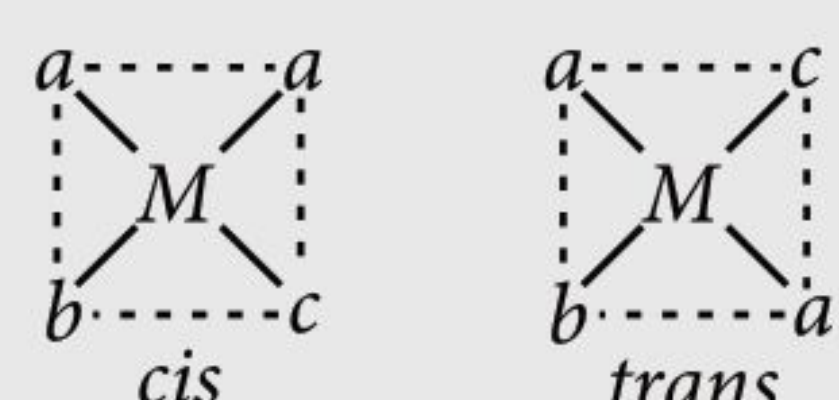
cis : 2 same ligands are arranged adjacent to each other.



trans : 2 same ligands are arranged opposite to each other.



In square planar complex $[\text{Ma}_2\text{bc}]$



In square planar complex $[\text{Mabcd}]$

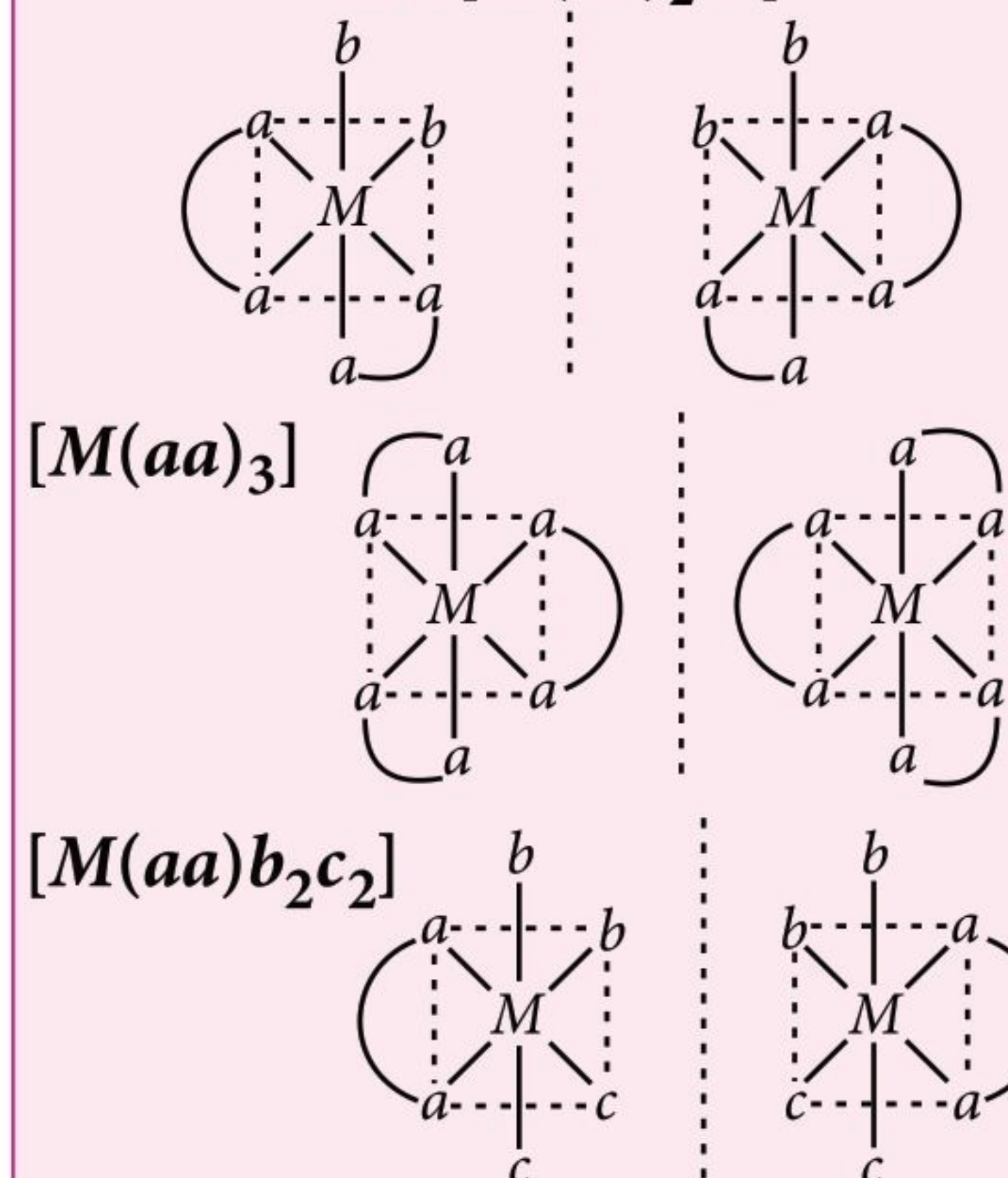
These isomers are obtained by selecting 1 ligand, (a) and then placing the remaining 3 ligands (b, c and d), one by one, *trans* to ligand (a). These type of complex shows three isomers – two *cis* and one *trans*.

Geometrical isomerism is not possible in tetrahedral complexes.

Optical isomerism

Shown by molecules which do not have plane of symmetry.

Optical isomerism in $[\text{M}(\text{aa})_2\text{b}_2]$ and $[\text{M}(\text{aa})_2\text{bc}]$



Optical isomerism is observed in tetrahedral complex of type $\text{M}(\text{AB})_2$ where AB is unsymmetrical bidentate ligand. **Square planar complexes** do not show optical isomerism because of plane of symmetry.

BONDING IN COORDINATION COMPOUNDS

Valence Bond Theory (VBT)

- It was developed by Pauling.

- A suitable number of vacant orbitals must be present in the central metal atom or ion for the formation of coordinate bonds with the ligands.
- Central metal ion can use appropriate number

of s , p or d -orbitals for hybridisation depending upon the total number of ligands.

- The outer orbital (high spin) or inner orbital (low spin) complexes are formed depending upon whether outer d -orbitals or inner d -orbitals are used.

- Low spin complexes are generally diamagnetic and high spin complexes are paramagnetic.
- Paramagnetism \propto No. of unpaired electrons.
- Magnetic moment $= \sqrt{n(n+2)}$ B.M. where n = number of unpaired electrons.

Coordination Number	Type of Hybridisation	Geometry	Examples
2	sp	Linear	$[\text{Ag}(\text{NH}_3)_2]^+$, $[\text{Ag}(\text{CN})_2]^-$
3	sp^2	Trigonal planar	$[\text{HgI}_3]^-$
4	sp^3	Tetrahedral	$\text{Ni}(\text{CO})_4$, $[\text{NiX}_4]^{2-}$, $[\text{ZnCl}_4]^{2-}$, $[\text{CuX}_4]^{2-}$, where $X = \text{Cl}^-$, Br^- , I^-
	dsp^2	Square planar	$[\text{Ni}(\text{CN})_4]^{2-}$, $[\text{Cu}(\text{NH}_3)_4]^{2+}$, $[\text{Ni}(\text{NH}_3)_4]^{2+}$
5	dsp^3	Trigonal bipyramidal	$\text{Fe}(\text{CO})_5$, $[\text{CuCl}_5]^{3-}$
	sp^3d	Square pyramidal	$[\text{SbF}_5]^{2-}$
6	d^2sp^3	Octahedral (Inner orbital)	$[\text{Cr}(\text{NH}_3)_6]^{3+}$, $[\text{Fe}(\text{CN})_6]^{3-}$
	sp^3d^2	Octahedral (Outer orbital)	$[\text{FeF}_6]^{3-}$, $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$, $[\text{Ni}(\text{NH}_3)_6]^{2+}$

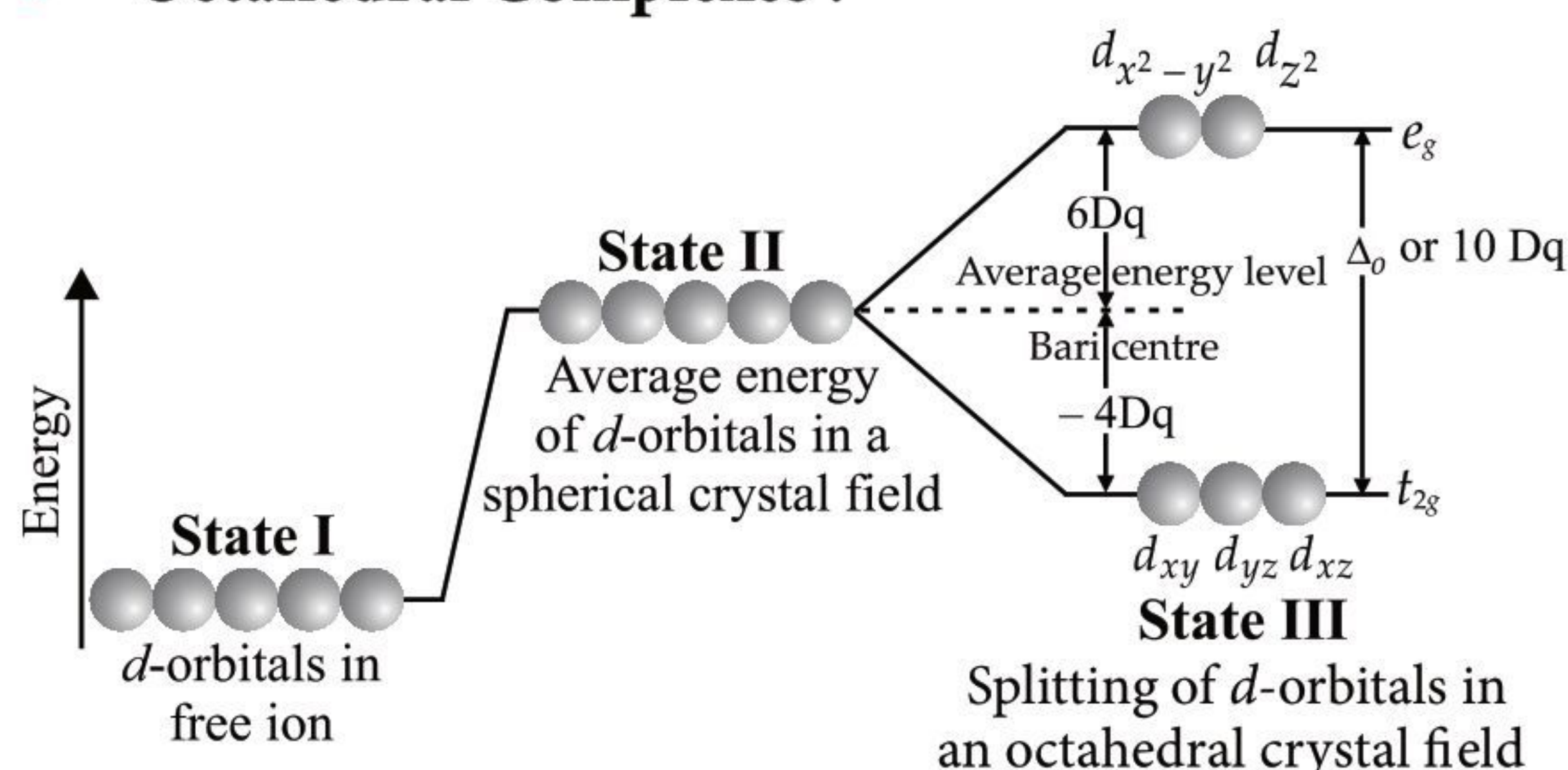
Differences between Inner Orbital Complexes and Outer Orbital Complexes

Inner Orbital Complexes	Outer Orbital Complexes
Involves inner d -orbitals <i>i.e.</i> , $(n-1)d$ -orbitals.	Involves outer d -orbitals <i>i.e.</i> , nd -orbitals
Low spin complexes	High spin complexes
Have less or no unpaired electrons, <i>e.g.</i> , $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{Co}(\text{CN})_6]^{4-}$	Have large number of unpaired electrons. <i>e.g.</i> , $[\text{MnF}_6]^{3-}$, $[\text{CoF}_6]^{3-}$

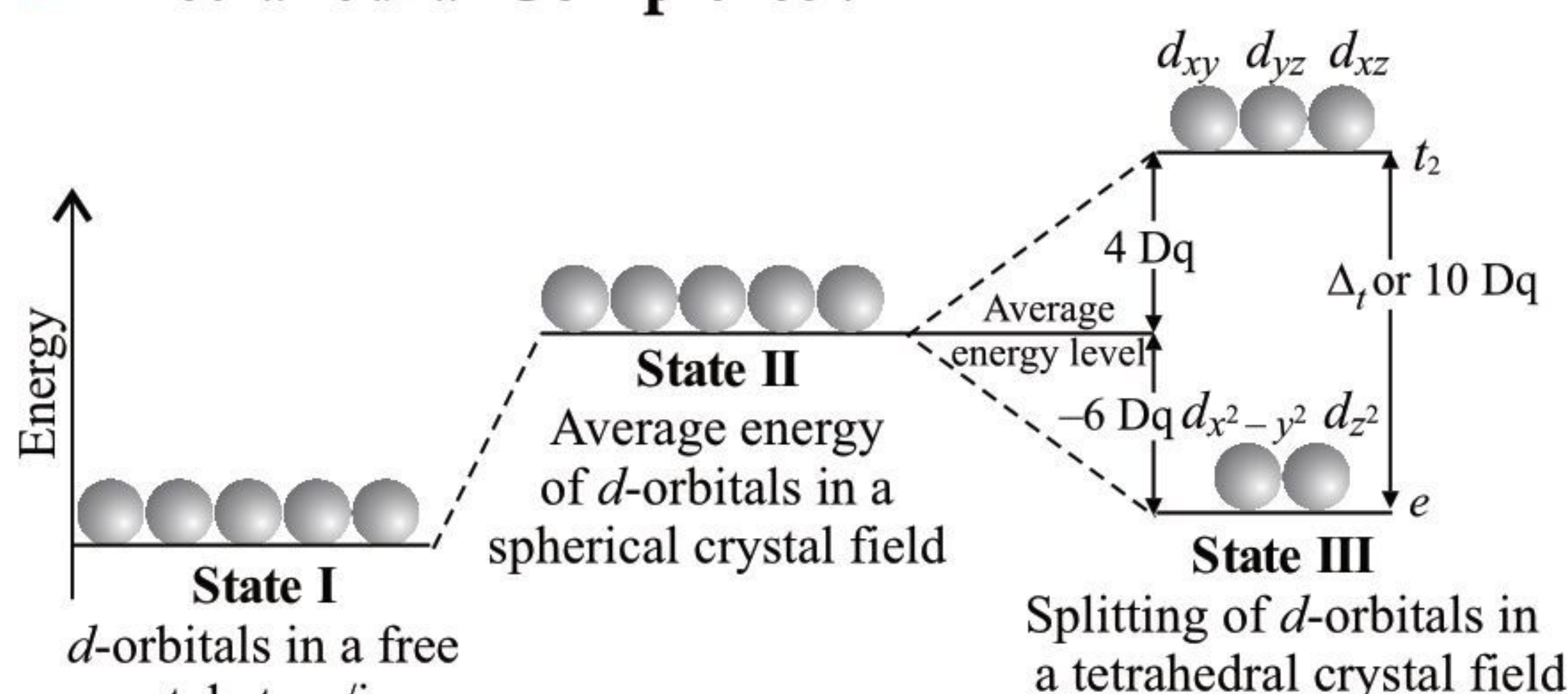
Crystal Field Theory (CFT)

It assumes the ligands to be point charges and there is electrostatic force of attraction between ligands and metal atom or ion. When ligands approach the central metal ion, then the five degenerate orbitals do not possess equal energy any more and results in splitting, which depends upon nature of ligand field strength. Greater the ease with which the ligand can approach the metal ion, the greater will be the crystal field splitting caused by it.

Octahedral Complexes :



Tetrahedral Complexes :



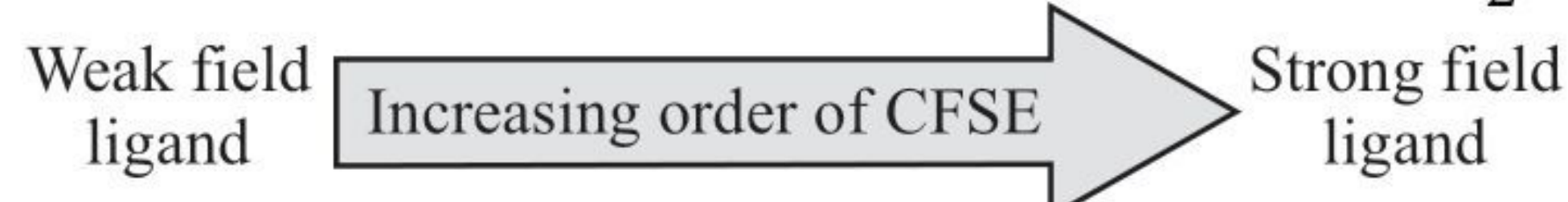
- If $\Delta_o < P$ (where ' P ' is energy required for forced pairing of electrons) then the electrons will remain unpaired and a high spin complex is formed.
- If $\Delta_o > P$, then pairing of electrons takes place and a low spin complex is formed.
 $\text{CFSE} = (-0.4x + 0.6y) \Delta_o$
 where x = number of electrons occupying t_{2g} orbitals.

y = number of electron occupying e_g orbitals.

- Difference in energy between e and t_2 level is less in tetrahedral complexes, $\Delta_t = \frac{4}{9}\Delta_o$

Spectrochemical Series

- When the ligands are arranged in the order of increasing field strength, the arrangement thus obtained is called spectrochemical series.
- $I^- < Br^- < SCN^- < Cl^- < S^{2-} < F^- < OH^- < C_2O_4^{2-} < H_2O < NCS^- < EDTA^{4-} < NH_3 < en < NO_2^- < CN^- < CO$



STABILITY OF COORDINATION COMPOUNDS

Stability depends on

Charge on the central metal ion (oxidation state) :
Greater the charge on central metal ion, more is the stability.

Basic nature of ligand :
More the basic strength of ligand, more is the stability of complex.

Presence of chelate rings :
Formation of chelate ring increases the stability of complex.

Size of the metal ion :
Smaller the size of metal ion, more is the stability.

Electronegativity and polarising power of the central metal ion : More is the electronegativity and polarising power of the metal ion, more stable is the complex.

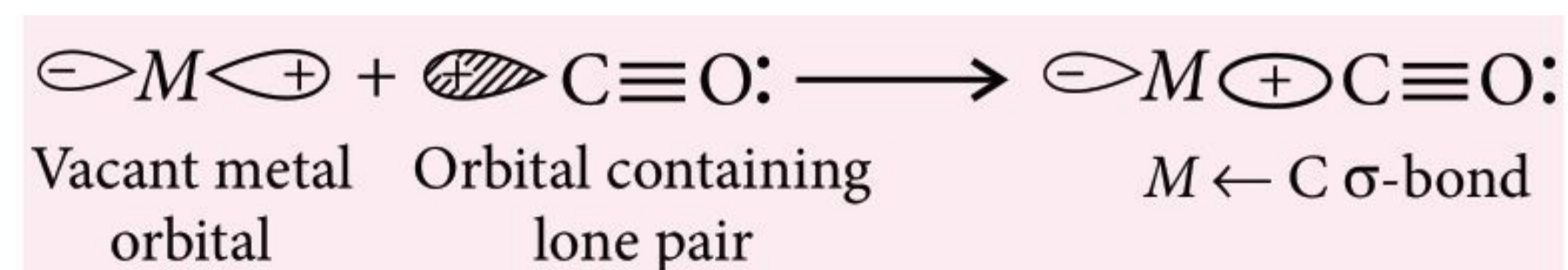
ORGANOMETALLIC COMPOUNDS

These are the compounds having one or more metal carbon bonds.

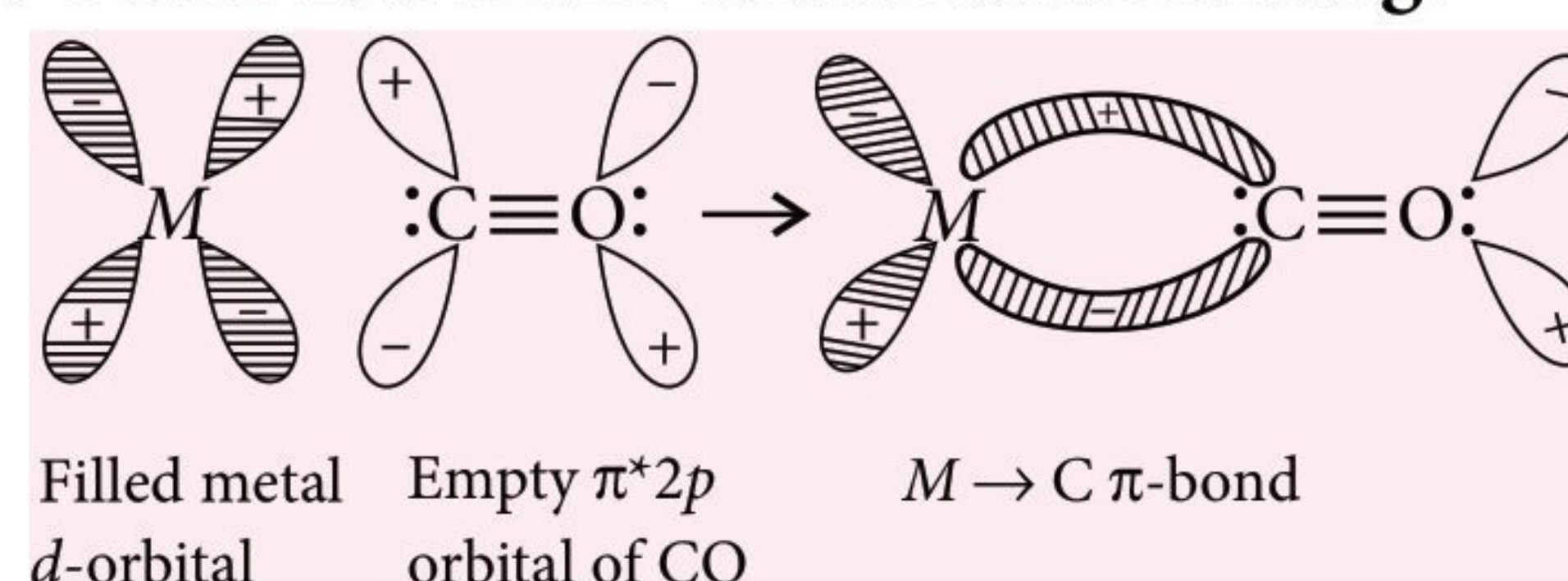
- **Types of organometallic compounds :**
Based on nature of metal - carbon bond, they are classified into :
 - **σ -bonded organometallic compounds :**
e.g.; $R-Mg-X$, $(C_2H_5)_2Zn$, etc.
 - **π -bonded organometallic compounds (π complexes) :** *e.g.*; Zeise's salt, $K[PtCl_3(\eta^2-C_2H_4)]$; ferrocene, $[Fe(\eta^5-C_5H_5)_2]$, etc.
 - **σ - and π -bonded organometallic compounds (Metal carbonyls) :** *e.g.*, $[Fe(CO)_5]$, $[Ni(CO)_4]$.

BONDING IN METAL CARBONYLS

- There is an overlap of filled $\pi 2p$ orbital of CO with suitable empty orbital of metal resulting in the formation of sigma bond.



- Then there is a π -overlap involving filled metal d -orbital and empty antibonding $\pi^* 2p$ orbital of same CO. This results in formation of $M \rightarrow C$ π -bond. This is also called **back bonding**.



APPLICATIONS OF COORDINATION COMPOUNDS

Complex $cis-[PtCl_2(NH_3)_2]$ known as *cis-platin* is used in cancer treatment.

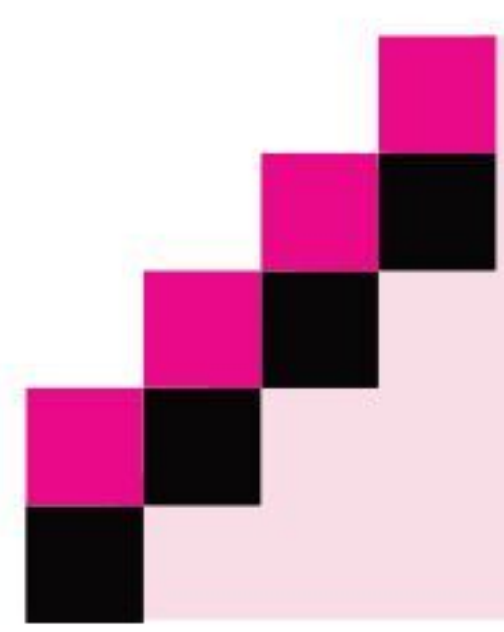
Coordination compounds are also used in electroplating, photography, dyes, etc.

Hardness of water can be estimated by complex formation using EDTA.

Coordination compounds are used as catalyst, *e.g.*, Wilkinson's catalyst, $(Ph_3P)_3RhCl$ Ziegler-Natta catalyst, $[TiCl_4 + (C_2H_5)_3Al]$

EDTA is often used for treatment of lead poisoning.

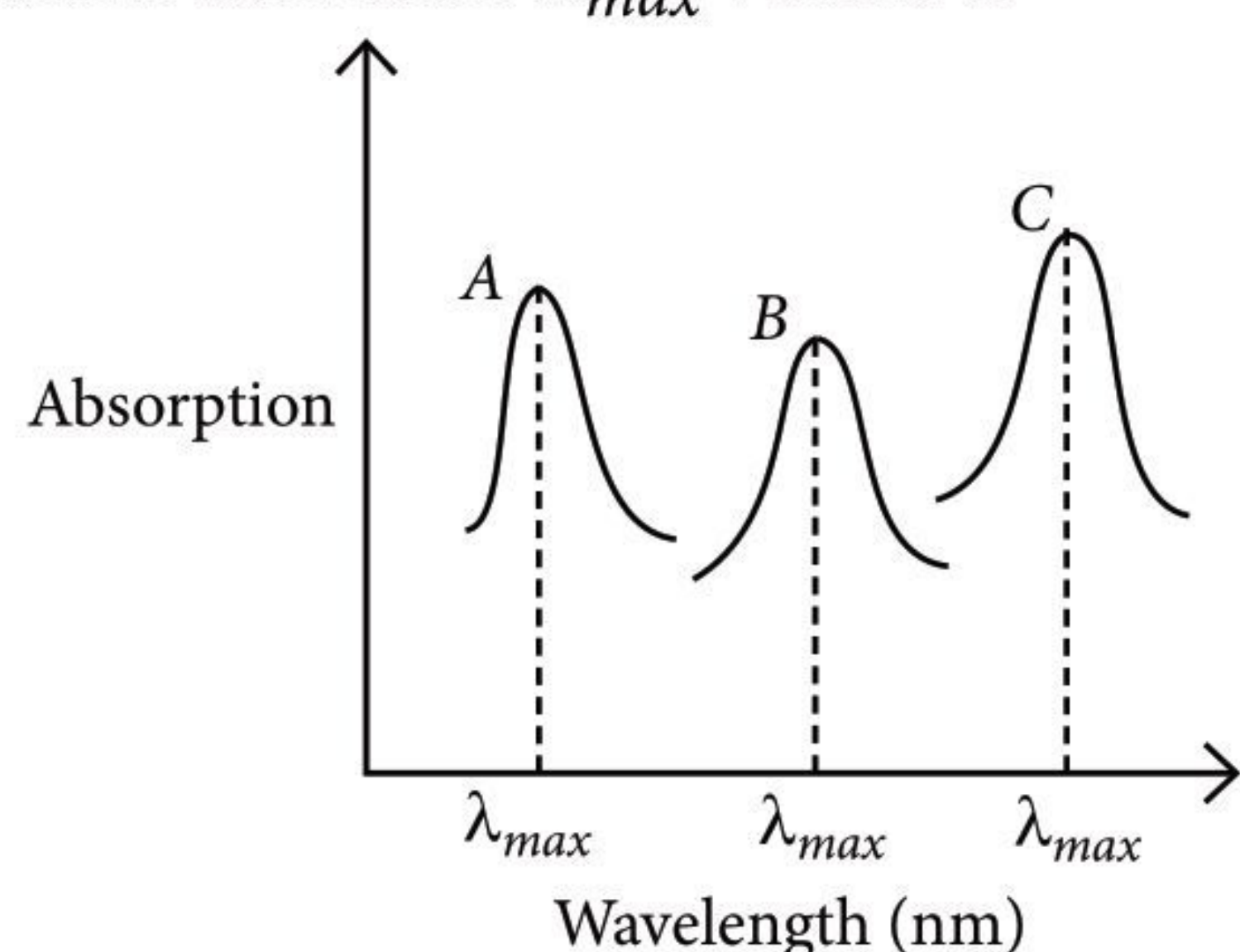
Coordination compounds are of great importance in biological system, *e.g.*, chlorophyll and haemoglobin, are coordinate compounds of Mg and Fe respectively.



WRAP it up!

MCQs Type

1. Simplified absorption spectra of three complexes ((i), (ii) and (iii)) of M^{n+} ion are provided below; their λ_{max} values are marked as A, B and C respectively. The correct match between the complexes and their λ_{max} values is



- (i) $[M(NCS)_6]^{(-6+n)}$ (ii) $[MF_6]^{(-6+n)}$
 (iii) $[M(NH_3)_6]^{n+}$
 (a) A-(iii), B-(i), C-(ii) (b) A-(ii), B-(i), C-(iii)
 (c) A-(i), B-(ii), C-(iii) (d) A-(ii), B-(iii), C-(i)
2. Which of the following will exhibit optical isomerism?
 (a) $[Cr(en)(H_2O)_4]^{3+}$ (b) $[Cr(en)_3]^{3+}$
 (c) $trans-[Cr(en)_2Cl_2]^+$ (d) $[Cr(NH_3)_6]^{3+}$
3. In $Fe(CO)_5$, the Fe – C bond possesses
 (a) π -character only
 (b) both σ and π characters
 (c) ionic character
 (d) σ -character only.
4. Consider the following complex, $[Co(NH_3)_5CO_3]ClO_4$. The coordination number, oxidation number, number of d -electrons and number of unpaired d -electrons on the metal are respectively
 (a) 6, +3, 6, 0 (b) 7, +2, 7, 1
 (c) 7, +1, 6, 4 (d) 6, +2, 7, 3
5. In the complexes $[Fe(H_2O)_6]^{3+}$, $[Fe(CN)_6]^{3-}$, $[Fe(C_2O_4)_3]^{3-}$ and $[FeCl_6]^{3-}$, more stability is shown by
 (a) $[Fe(H_2O)_6]^{3+}$ (b) $[Fe(CN)_6]^{3-}$
 (c) $[Fe(C_2O_4)_3]^{3-}$ (d) $[FeCl_6]^{3-}$
6. The difference in the number of unpaired electrons of a metal ion in its high-spin and low-spin octahedral complexes is two. The metal ion is

- (a) Ni^{2+} (b) Co^{2+}
 (c) Mn^{2+} (d) Fe^{2+}

7. Which one of the following complex species does not obey the EAN rule?
 (a) $[Cu(CN)_4]^{3-}$ (b) $[Cr(NH_3)_6]^{3+}$
 (c) $[Fe(CN)_6]^{4-}$ (d) $[Ni(CO)_4]$
8. Which of the following has largest number of isomers? (R = alkyl group, en = ethylenediamine)
 (a) $[Ru(NH_3)_4Cl_2]^+$ (b) $[Co(NH_3)_5Cl]^{2+}$
 (c) $[Ir(PR_3)_2H(CO)]^{2+}$ (d) $[CoCl_2(en)_2]^+$
9. The complex ion which has no d electrons in the central metal atom is
 (a) $[MnO_4]^-$ (b) $[Co(NH_3)_6]^{3+}$
 (c) $[Fe(CN)_6]^{3-}$ (d) $[Cr(H_2O)_6]^{3+}$
10. Which of the following has longest C—O bond length? (Free C—O bond length in CO is 1.128 Å.)
 (a) $[Fe(CO)_4]^{2-}$ (b) $[Mn(CO)_6]^+$
 (c) $[Ni(CO)_4]$ (d) $[Co(CO)_4]^-$
11. P , Q and R are three complexes of chromium (III) with the empirical formula $H_{12}O_6Cl_3Cr$. All the three complexes have water and chloride ion as ligands. Complex P does not react with concentrated H_2SO_4 , whereas complexes Q and R lose 6.75% and 13.5% of their original mass, respectively, on treatment with concentrated H_2SO_4 . Identify P , Q and R .
 (a) $P - [Cr(H_2O)_6]Cl_3$, $Q - [Cr(H_2O)_5Cl] \cdot (H_2O)Cl_2$,
 $R - [Cr(H_2O)_4Cl_2] \cdot (H_2O)_2Cl$
 (b) $P - [Cr(H_2O)_5Cl] \cdot (H_2O)Cl_2$, $Q - [Cr(H_2O)_6]Cl_3$,
 $R - [Cr(H_2O)_4Cl_2] \cdot (H_2O)_2Cl$
 (c) $P - [Cr(H_2O)_4Cl_2] \cdot (H_2O)_2Cl$,
 $Q - [Cr(H_2O)_5Cl] \cdot (H_2O)Cl_2$, $R - [Cr(H_2O)_6]Cl_3$
 (d) $P - [Cr(H_2O)_6]Cl_3$, $Q - [Cr(H_2O)_4Cl_2] \cdot (H_2O)_2Cl$,
 $R - [Cr(H_2O)_5Cl] \cdot (H_2O)Cl_2$
12. The one that is not expected to show isomerism is
 (a) $[Ni(NH_3)_4(H_2O)_2]^{2+}$ (b) $[Ni(NH_3)_2Cl_2]$
 (c) $[Ni(en)_3]^{2+}$ (d) $[Pt(NH_3)_2Cl_2]$
13. Excess of silver nitrate solution is added to 100 mL of 0.01 M pentaquachloridochromium(III)

chloride solution. The mass of silver chloride obtained in grams is

[Atomic mass of silver is 108]

- (a) 287×10^{-3} (b) 143.5×10^{-3}
(c) 143.5×10^{-2} (d) 287×10^{-2}

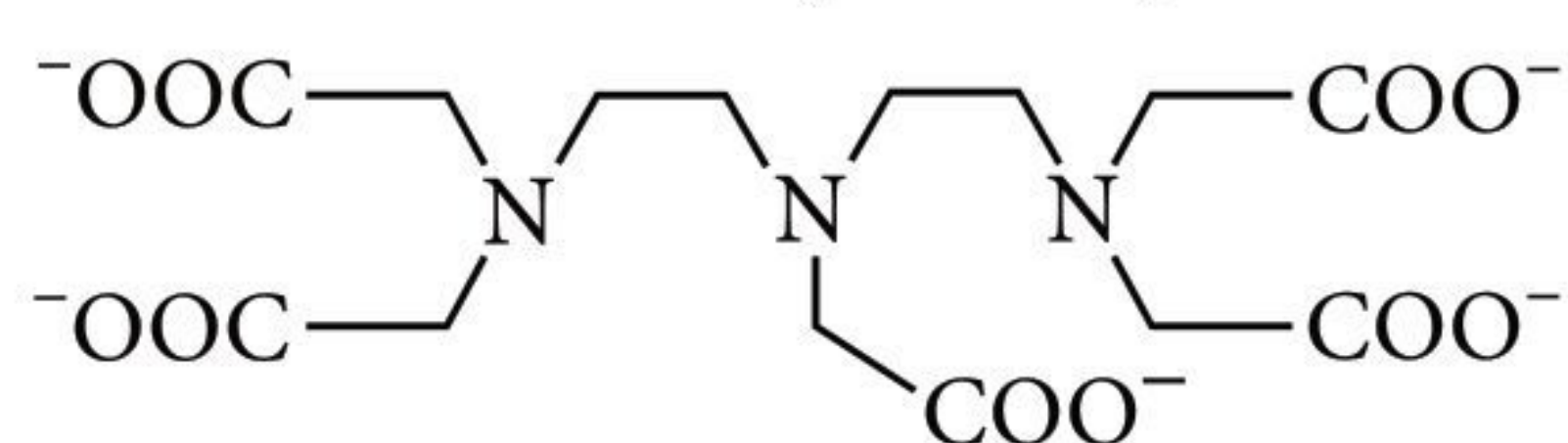
14. The coordination number and the oxidation state of the element E in the complex $[E(en)_2(C_2O_4)]NO_2$ (where (en) is ethylenediamine) are, respectively

- (a) 6 and +3 (b) 6 and +2
(c) 4 and +2 (d) 4 and +3

15. The IUPAC name of $K_2[Ni(CN)_4]$ is

- (a) potassium tetracyanidonickelate(II)
(b) potassium tetracyanatonickelate(III)
(c) potassium tetracyanatonickel(II)
(d) potassium tetracyanonickel(III).

16. The maximum possible denticities of a ligand given below towards a common transition and inner-transition metal ion, respectively, are



- (a) 8 and 6 (b) 8 and 8
(c) 6 and 8 (d) 6 and 6

(JEE Main 2019)

17. According to IUPAC system, what is the correct name of the compound $[Cr(NH_3)_3(H_2O)_3]Cl_3$?

- (a) Triamminetriaquachromium(III) chloride
(b) Triamminetriaquachromium chloride(III)
(c) Tetraammoniumtriaquachromium(III) chloride
(d) None of the above

18. The type of hybridisation and magnetic property of the complex $[MnCl_6]^{3-}$, respectively are

- (a) sp^3d^2 and diamagnetic
(b) d^2sp^3 and paramagnetic
(c) sp^3d^2 and paramagnetic
(d) d^2sp^3 and diamagnetic.

19. What is the correct electronic configuration of the central atom in $K_4[Fe(CN)_6]$ based on crystal field theory?

- (a) $e^4 t_2^2$ (b) $t_{2g}^4 e_g^2$ (c) $t_{2g}^6 e_g^0$ (d) $e^3 t_2^3$

(NEET2019)

20. The correct statement on the isomerism associated with the following complex ions,

(1) $[Ni(H_2O)_5(NH_3)]^{2+}$ (2) $[Ni(H_2O)_4(NH_3)_2]^{2+}$ and (3) $[Ni(H_2O)_3(NH_3)_3]^{2+}$ is

- (a) (1) and (2) show only geometrical isomerism
(b) (1) and (2) show geometrical and optical isomerism
(c) (2) and (3) show geometrical and optical isomerism
(d) (2) and (3) show only geometrical isomerism.

21. When $AgCl$ is treated with KCN

- (a) Ag is precipitated
(b) a complex ion is formed
(c) double decomposition takes place
(d) no reaction takes place.

22. Arrange the following cobalt complexes in the order of increasing Crystal Field Stabilization Energy (CFSE) value.

Complexes: $[CoF_6]^{3-}$, $[Co(H_2O)_6]^{2+}$, $[Co(NH_3)_6]^{3+}$
and $[Co(en)_3]^{3+}$
A B C D

Choose the correct option.

- (a) $B < C < D < A$ (b) $B < A < C < D$
(c) $A < B < C < D$ (d) $C < D < B < A$

(JEE Main 2021)

23. Ethylene diaminetetraacetate (EDTA) ion is

- (a) tridentate ligand with three "N" donor atoms
(b) hexadentate ligand with four "O" and two "N" donor atoms
(c) unidentate ligand
(d) bidentate ligand with two "N" donor atoms.

24. As per IUPAC norms, the name of the complex $[Co(en)_2(ONO)Cl]Cl$ is

- (a) Chloridobis(ethane-1,2-diamine)nitro-O-cobalt(III) chloride
(b) Chlorobis(ethylenediamine)nitrocobalt(III) chloride
(c) Chloridodi(ethylenediamine)nitrocobalt(III) chloride
(d) Chloroethylenediaminenitro-O-cobalt (III) chloride.

25. Match List-I with List-II.

List I		List II	
(A)	$[Fe(CN)_6]^{3-}$	(i)	5.92 BM
(B)	$[Fe(H_2O)_6]^{3+}$	(ii)	0 BM
(C)	$[Fe(CN)_6]^{4-}$	(iii)	4.90 BM
(D)	$[Fe(H_2O)_6]^{2+}$	(iv)	1.73 BM

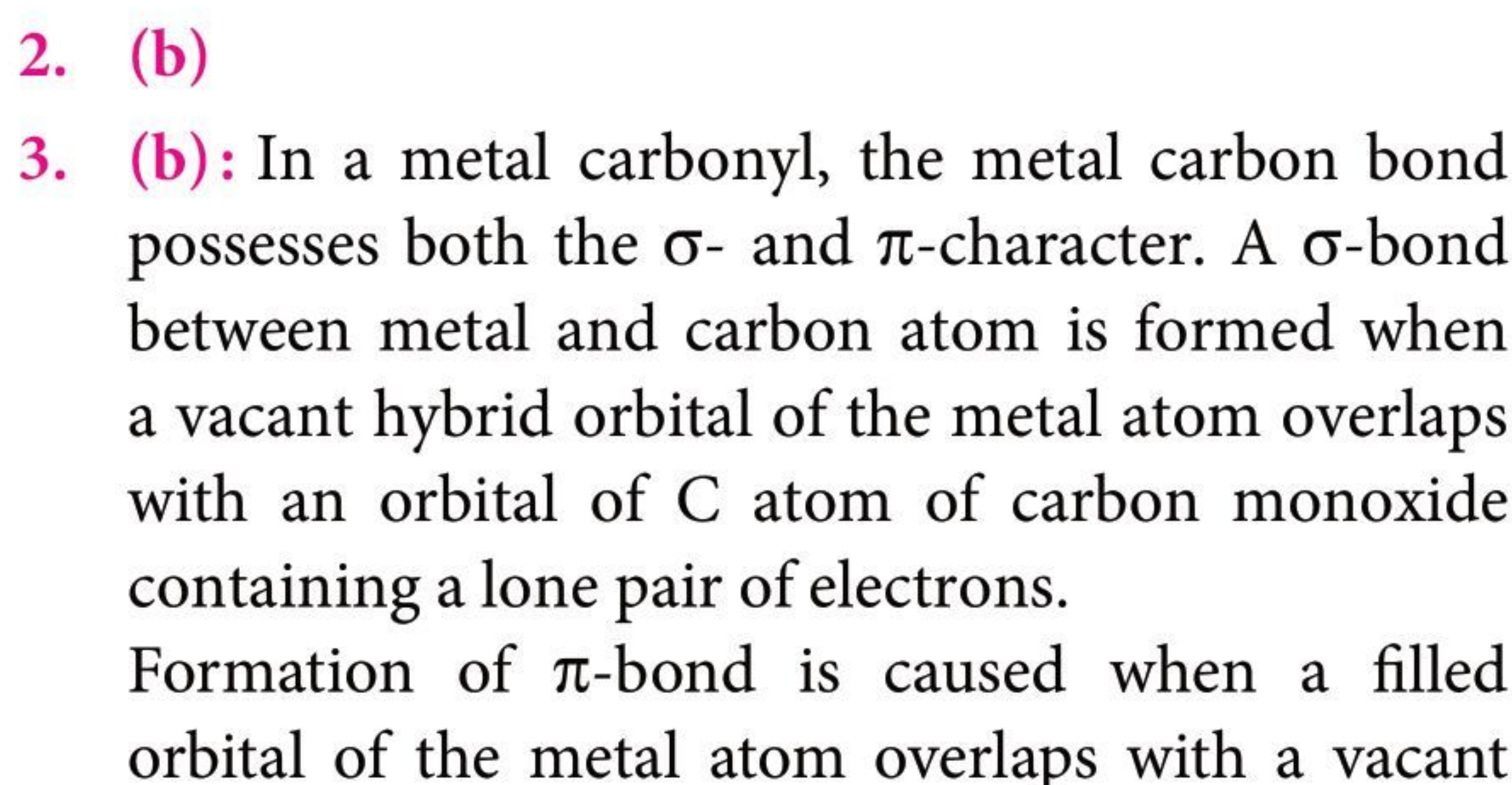
(a) (A) – (iv), (B) – (i), (C) – (ii), (D) – (iii)
 (b) (A) – (iv), (B) – (ii), (C) – (i), (D) – (iii)
 (c) (A) – (ii), (B) – (iv), (C) – (iii), (D) – (i)
 (d) (A) – (i), (B) – (iii), (C) – (iv), (D) – (ii)

26. The oxidation states of iron atoms in compounds (A), (B) and (C), respectively, are x , y and z . The sum of x , y and z is _____.

$\text{Na}_4[\text{Fe}(\text{CN})_5(\text{NOS})]$	$\text{Na}_4[\text{FeO}_4]$	$[\text{Fe}_2(\text{CO})_9]$
(A)	(B)	(C)

27. The number of chelate rings present in the complex $K_2[Ni(EDTA)]$ is _____.
28. The coordination number of the element M in the complex $M(DMG)_2$ (where DMG is dimethylglyoxime) is _____.
29. 1 mol of an octahedral metal complex with formula $MCl_3 \cdot 2L$ on reaction with excess of $AgNO_3$ gives 1 mol of $AgCl$. The denticity of ligand L is _____.
30. The number of bridged CO groups present in octacarbonyldicobalt (0) is _____.

1. **(a):** Strong field ligand causes greater splitting between two energy levels. Thus, for a strong field ligand, the energy $\left(h\nu = \frac{hc}{\lambda}\right)$ of light absorbed is more and the wavelength of light absorbed is less. According to the graph, $\lambda_{\max(C)} > \lambda_{\max(B)} > \lambda_{\max(A)}$. Thus, the order of field strength will be : $A > B > C$. According to spectrochemical series, field strength is as :

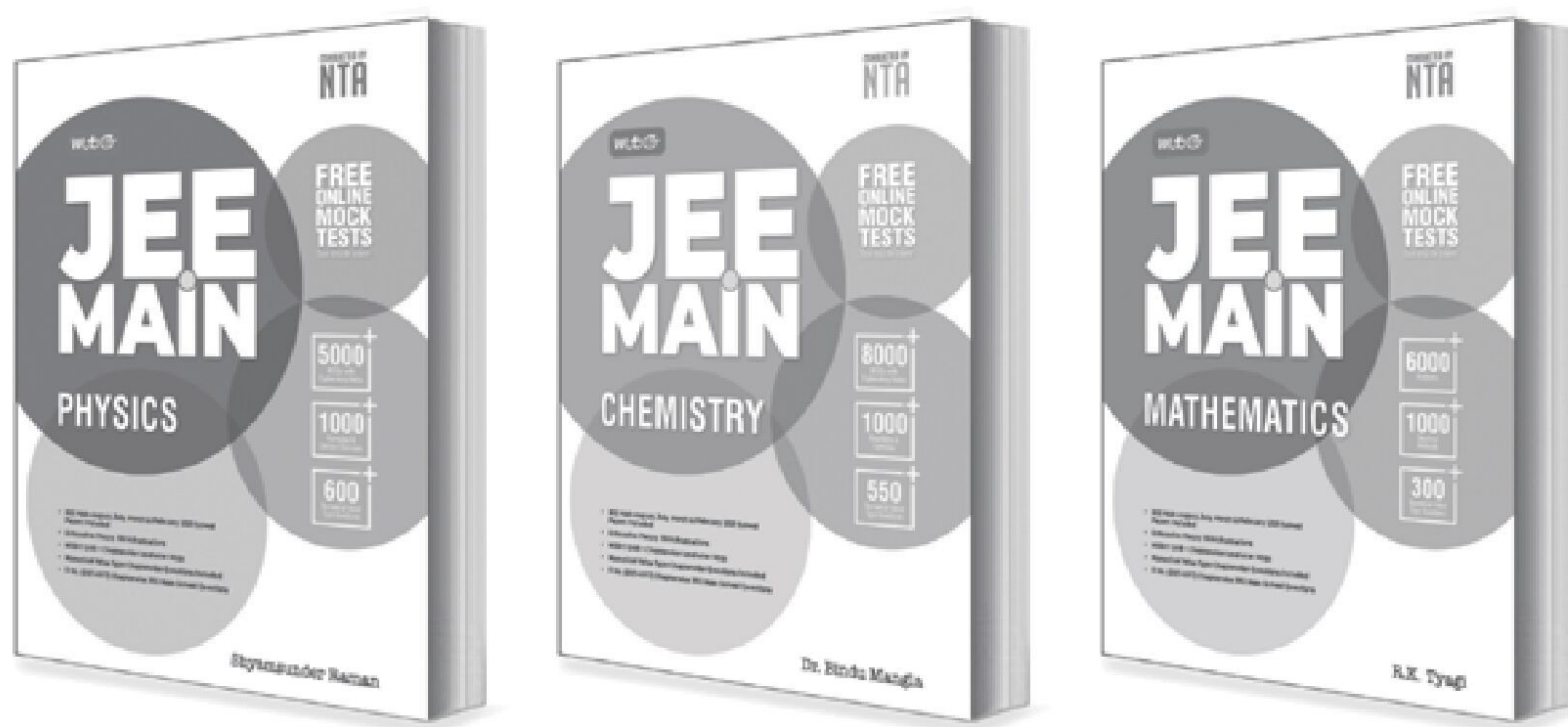


<p>Co in $[\text{Co}(\text{NH}_3)_6]^{3+}$ is Co^{3+} <i>i.e.</i> $3d^6$</p> <p>Fe in $[\text{Fe}(\text{CN})_6]^{3-}$ is Fe^{3+} <i>i.e.</i> $3d^5$</p> <p>Cr in $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$ is Cr^{3+} <i>i.e.</i> $3d^3$.</p>	<p style="text-align: center;">All of these have certain number of <i>d</i>-electrons</p>
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10. (a): The greater the negative charge on the carbonyl complex, the more easy it would be for the metal to permit its electrons to participate in the back bonding, the higher would be the $M-C$ bond order and simultaneously there would be larger reduction in the $C-O$ bond order. Thus, $[Fe(CO)_4]^{2-}$ has the lowest $C-O$ bond order, means the longest bond length.

11. (a): Since there is no action of concentrated H_2SO_4 on compound P so it can be assumed that all molecules of water in P are coordinated with Cr^{3+} ion. Its structure would be $[Cr(H_2O)_6]Cl_3$. Compound Q loses 6.75% of its original mass on being treated with concentrated H_2SO_4 . The loss in mass is due to removal of water molecules that are not directly coordinated to Cr^{3+} ion.

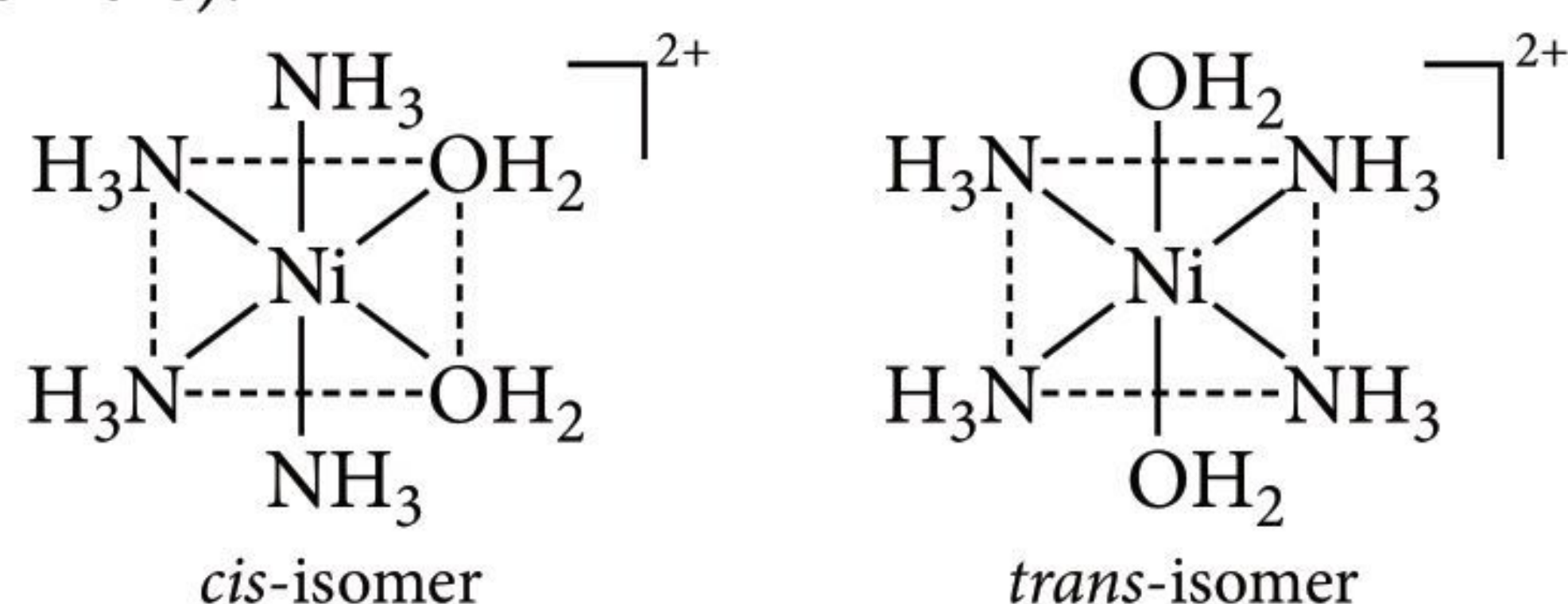
\therefore Mass of water lost from Q per mole

$$= \frac{6.75}{100} \times 266.5 \text{ g} = 17.98 \text{ g} \quad [\text{Molar mass} = 266.5]$$

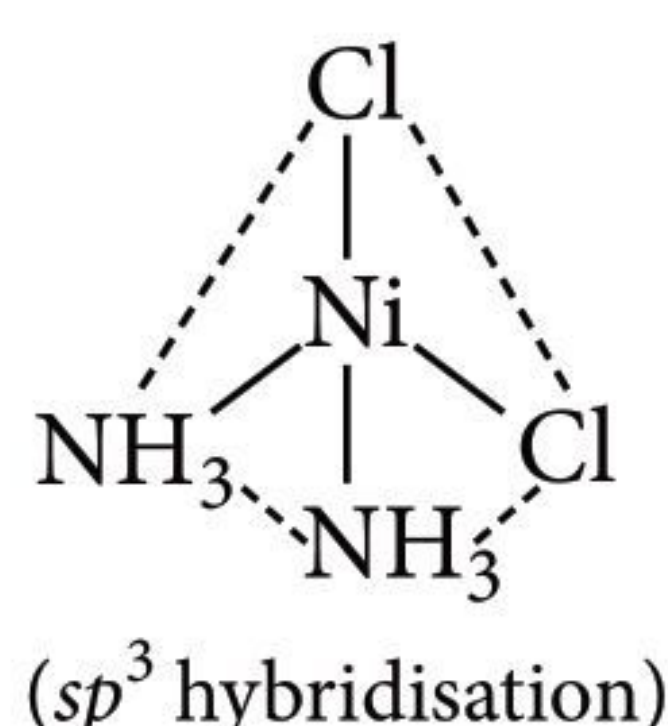
This loss of mass corresponds to loss of 1 molecule of water. Therefore the structure of complex Q is $[Cr(H_2O)_5Cl](H_2O)Cl_2$.

In compound R the mass lost is 13.5%, when R is treated with concentrated H_2SO_4 . The loss in mass is 2 times ($2 \times 6.75 = 13.5$) the loss in mass in case of Q . This loss corresponds to 2 molecules of water. So, the structure of R is $[Cr(H_2O)_4Cl_2](H_2O)_2Cl$.

12. (b): $[Ni(NH_3)_4(H_2O)_2]^{2+}$ -Octahedral geometry exhibits geometrical isomerism (*cis*- and *trans*-isomers).

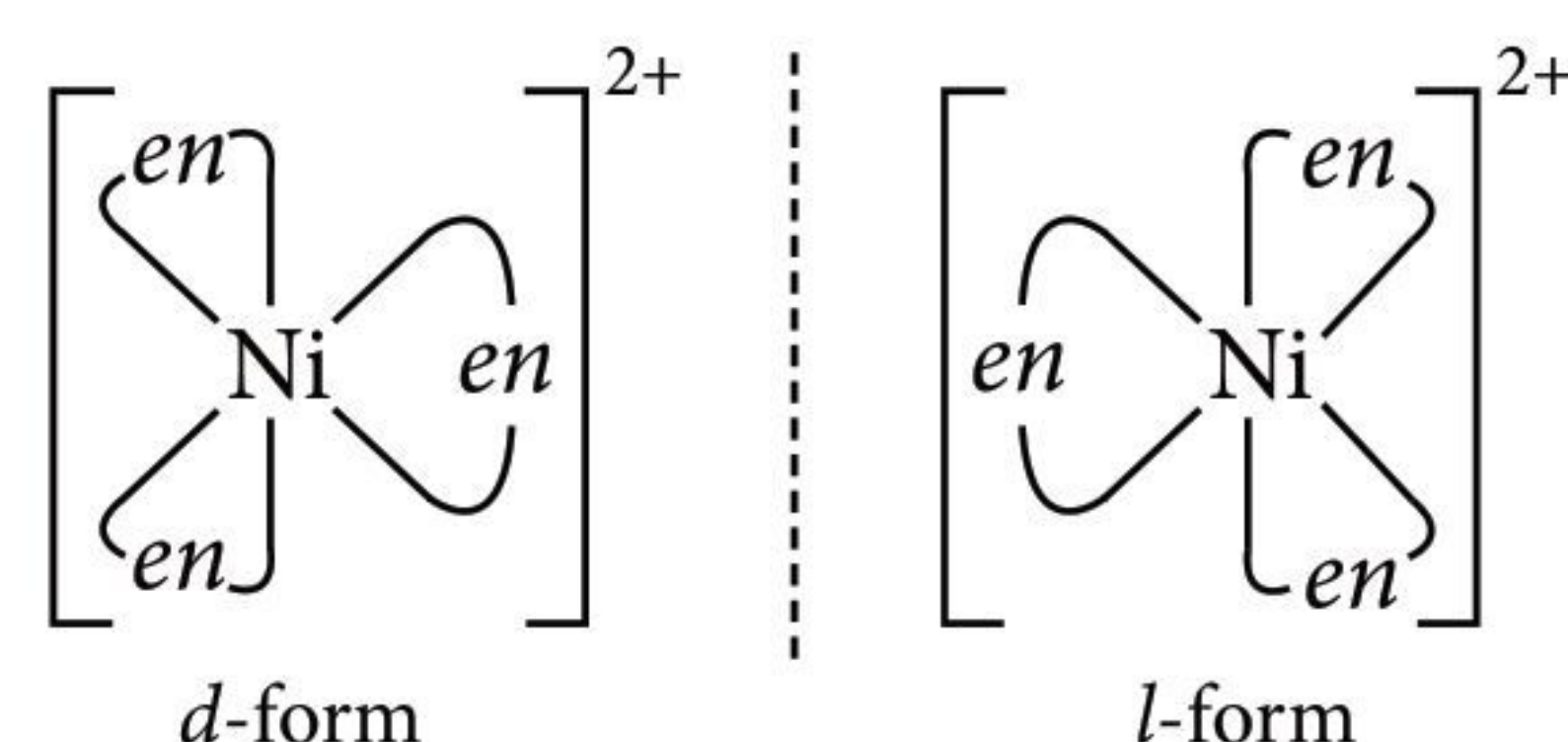


$[Ni(NH_3)_2Cl_2]$ -Tetrahedral geometry
 $Ni^{2+} : 3d^8 4s^0$

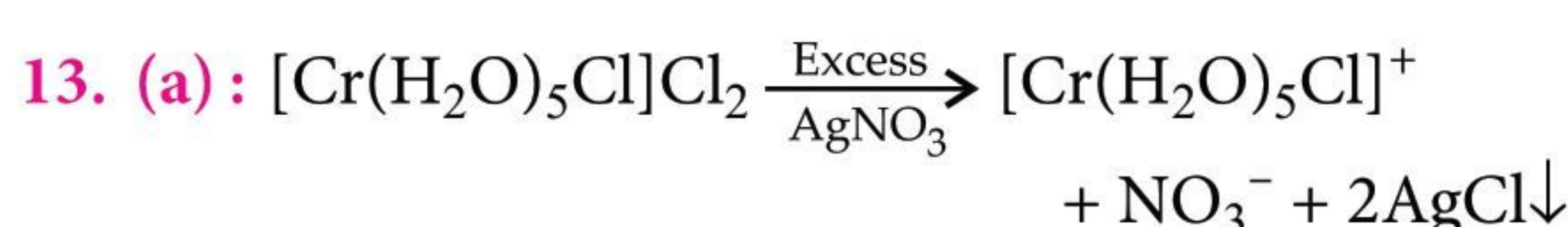
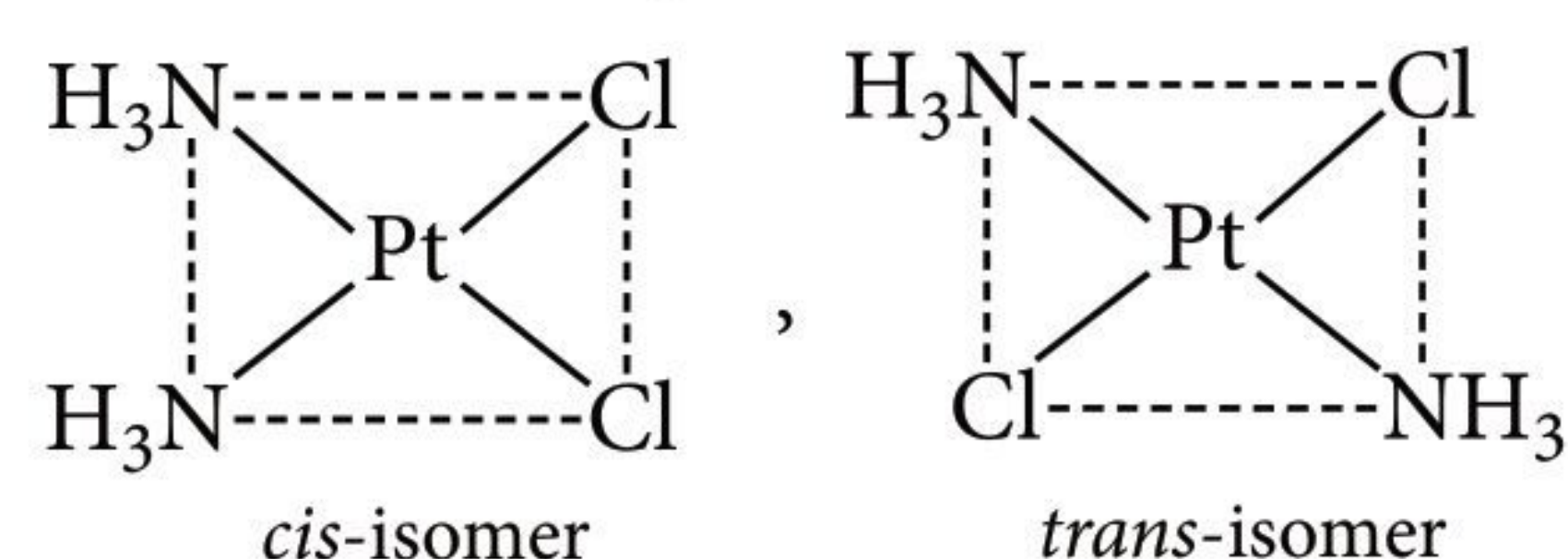


It does not show any isomerism.

$[Ni(en)_3]^{2+}$ - Octahedral geometry, shows optical isomerism.



$[Pt(NH_3)_2Cl_2]$ - Square planar geometry. It shows *cis-trans*-isomers i.e., geometrical isomerism.



Thus, Meq. of Cl^- ions outside = Meq. of $AgCl$ formed

$$\therefore \text{Number of moles of } Cl^- \text{ ions present} = \frac{2 \times 100 \times 0.01}{1000} = 0.002 \text{ moles}$$

$$\therefore \text{Mass of } AgCl = 0.002 \times 143.5 = 0.287 \text{ g} = 287 \times 10^{-3} \text{ g}$$

14. (a): In the given complex $[E(en)_2(C_2O_4)]^+ NO_2^-$ ethylene diamine is a bidentate ligand and $(C_2O_4^{2-})$ i.e., oxalate ion is also bidentate ligand. Therefore, coordination number of the complex is 6 i.e., it is an octahedral complex.

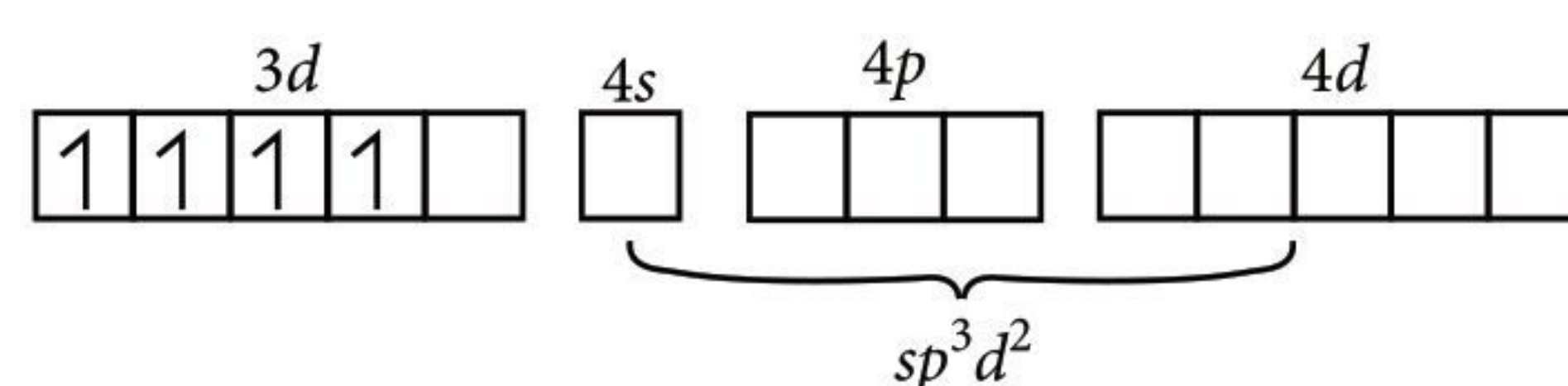
Oxidation number of E in the given complex is :

$$x + 2 \times 0 + 1 \times (-2) = +1 \Rightarrow x = +3$$

15. (a) 16. (c) 17. (a)

18. (c): E.C. of $Mn^{3+} : [Ar] 3d^4$

Mn^{3+} ion in $[MnCl_6]^{3-}$:



Hybridisation : $sp^3 d^2$ with 4 unpaired electrons.

MONTHLY TEST DRIVE CLASS XI ANSWER KEY

- | | | | | |
|-------------|-------------|-------------|------------|---------------|
| 1. (d) | 2. (c) | 3. (b) | 4. (a) | 5. (a) |
| 6. (a) | 7. (b) | 8. (b) | 9. (c) | 10. (b) |
| 11. (c) | 12. (d) | 13. (c) | 14. (a) | 15. (a) |
| 16. (a) | 17. (b) | 18. (b) | 19. (b) | 20. (a,b,c,d) |
| 21. (a,b,c) | 22. (a,b,c) | 23. (a,b,d) | 24. (92.5) | 25. (2) |
| 26. (3) | 27. (c) | 28. (b) | 29. (d) | 30. (a) |

$$\text{Fe}^{2+} : \begin{array}{|c|c|c|c|c|} \hline \text{3d} \\ \hline \uparrow\downarrow & \uparrow & \uparrow & \uparrow & \uparrow \\ \hline \end{array} \quad \begin{array}{|c|} \hline \text{4s} \\ \hline \\ \hline \end{array}$$

20. (d)

22. (b): Order of ability to cause splitting :

Hence CFSE order :

 B

A

C

$$D$$

24. (a)

$3d$ $4s$ $4p$
 $\uparrow\downarrow$ $\uparrow\downarrow$ \uparrow $\times\times$ $\times\times$ $\times\times$ $\times\times$ $\times\times$ $\times\times$

where n = number of unpaired electrons.

Hence, $n = 1$.

$[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$:

$3d$					$4s$	$4p$		
↑	↑	↑	↑	↑	xx	xx	xx	xx
						$4d$		
						xx	xx	

$$[\text{Fe}(\text{CN})_6]^{4-} : \begin{array}{c} 3d \\ \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \times \times \times \times \\ \boxed{} \boxed{} \boxed{} \boxed{} \boxed{} \end{array} \begin{array}{c} 4s \\ \times \times \\ \boxed{} \boxed{} \end{array} \begin{array}{c} 4p \\ \times \times \times \times \times \times \\ \boxed{} \boxed{} \boxed{} \boxed{} \boxed{} \boxed{} \end{array}$$

$[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$:

$3d$					$4s$		$4p$		
↑↓	↑	↑	↑	↑	××		××	××	××

$4d$				
××	××			

27. (5)

CN(C)C1=NC(=O)N(C)C(=O)N1CO=C1C(=O)C(C1)(C(C)(C)OC)C(C)(C)OC

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Exam on
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2021

CLASS-XII

TERM-I OBJECTIVE TYPE QUESTIONS

Practice Paper 2021

Time allowed : 90 minutes
Maximum marks : 35

GENERAL INSTRUCTIONS

1. The Question Paper contains three sections.
2. Section A has 25 questions. Attempt any 20 questions.
3. Section B has 24 questions. Attempt any 20 questions.
4. Section C has 6 questions. Attempt any 5 questions.
5. All questions carry equal marks.
6. There is no negative marking.

- The Solid State
- Solutions
- The *p*-Block Elements
- Haloalkanes and Haloarenes
- Alcohols, Phenols and Ethers
- Biomolecules

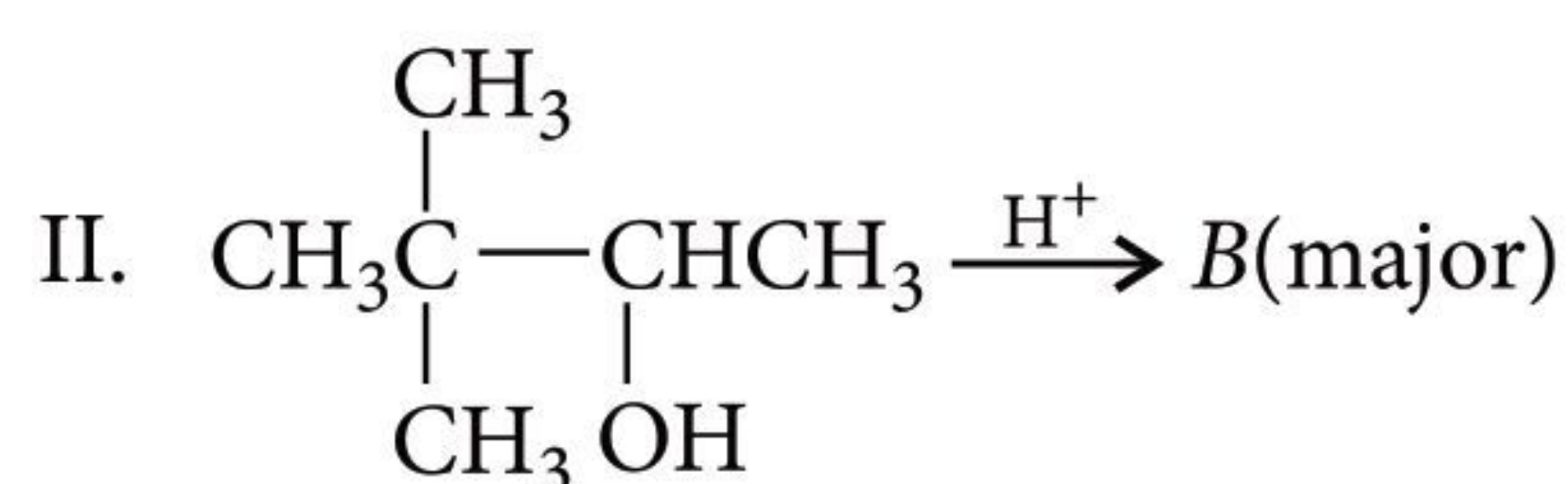
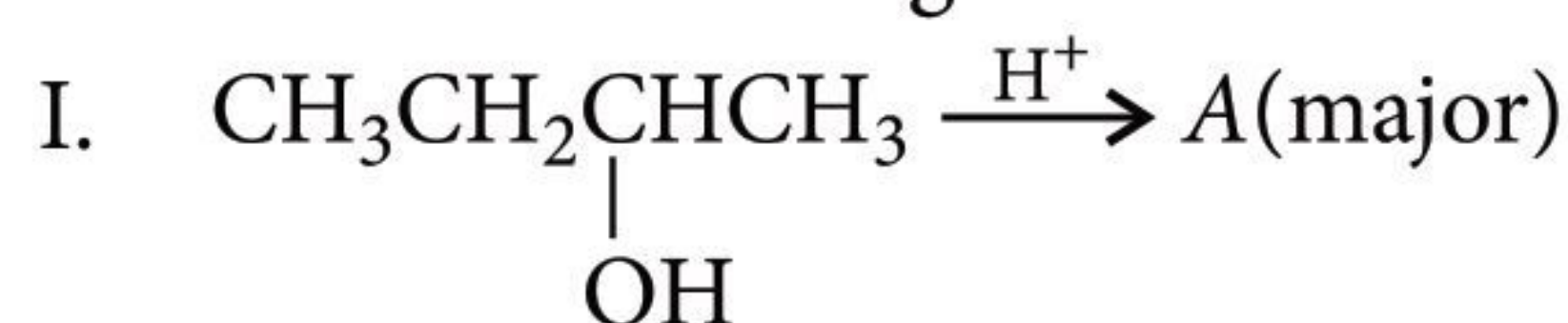
SECTION - A

This section consists of 25 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation.

1. Rhombic sulphur consists of
 - (a) cubic geometry
 - (b) monoclinic geometry
 - (c) tetragonal geometry
 - (d) orthorhombic geometry.
2. Which of the following products are obtained when concentrated sulphuric acid reacts with carbon?
 - (a) SO₂ only
 - (b) CO₂ only
 - (c) SO₂ and CO₂
 - (d) CO and SO₃
3. Among the following statements which one is incorrect?
 - (a) Nitrogen has the ability to form *pπ-pπ* bonds with itself.
 - (b) Bismuth forms metallic bonds in elemental state.

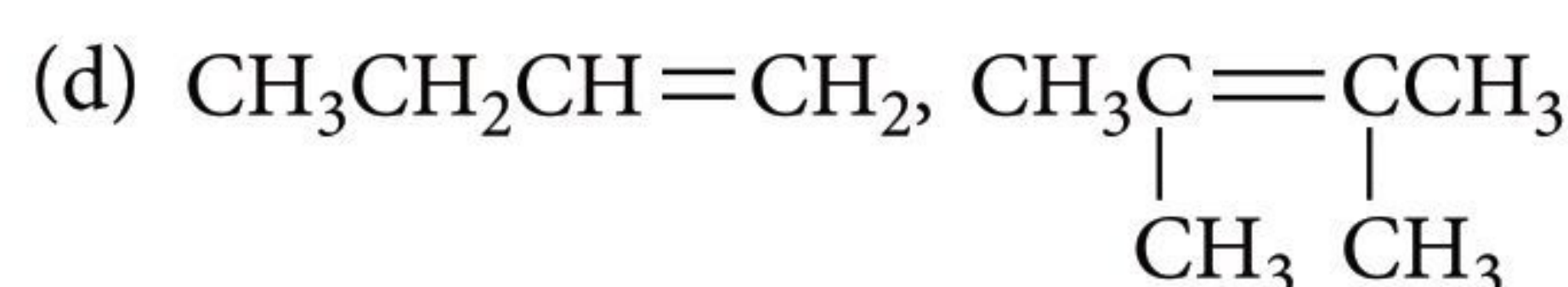
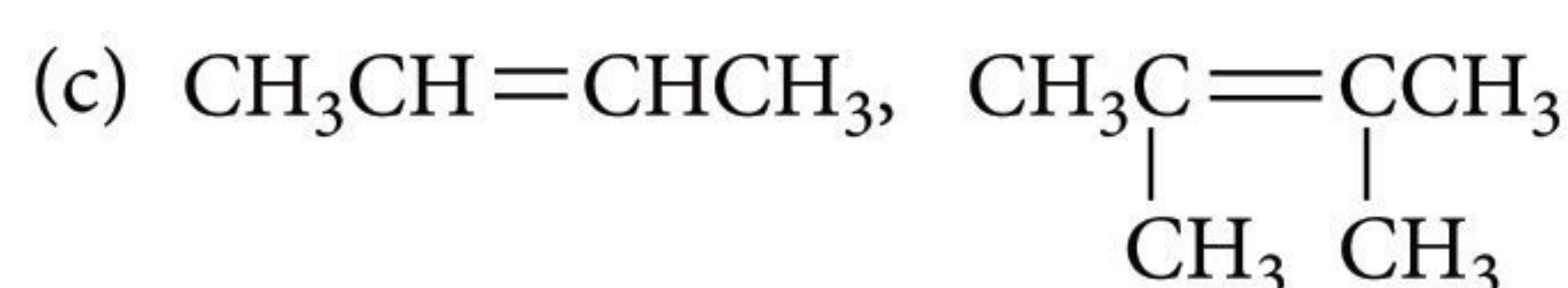
- (c) Catenation tendency is higher in nitrogen when compared with other elements of the same group.
- (d) Nitrogen has higher first ionization enthalpy when compared with other elements of the same group.

4. Consider the following reactions :



A and B are respectively

- (a) CH₃CH=CHCH₃, $\text{CH}_3\underset{\text{CH}_3}{\overset{\text{CH}_3}{\text{C}}}\text{CH}=\text{CH}_2$
- (b) CH₃CH₂CH=CH₂, $\text{CH}_3\underset{\text{CH}_3}{\overset{\text{CH}_3}{\text{C}}}\text{CH}=\text{CH}_2$



5. An organic compound of molecular formula $\text{C}_4\text{H}_{10}\text{O}$ does not react with sodium. With excess of HI, it gives only one type of alkyl halide. The compound is

(a) ethoxyethane (b) 2-methoxypropane
(c) 1-methoxypropane (d) 1-butanol.

6. In $\text{S}_\text{N}2$ reactions, the correct order of reactivity for the following compounds :

CH_3Cl , $\text{CH}_3\text{CH}_2\text{Cl}$, $(\text{CH}_3)_2\text{CHCl}$ and $(\text{CH}_3)_3\text{CCl}$ is

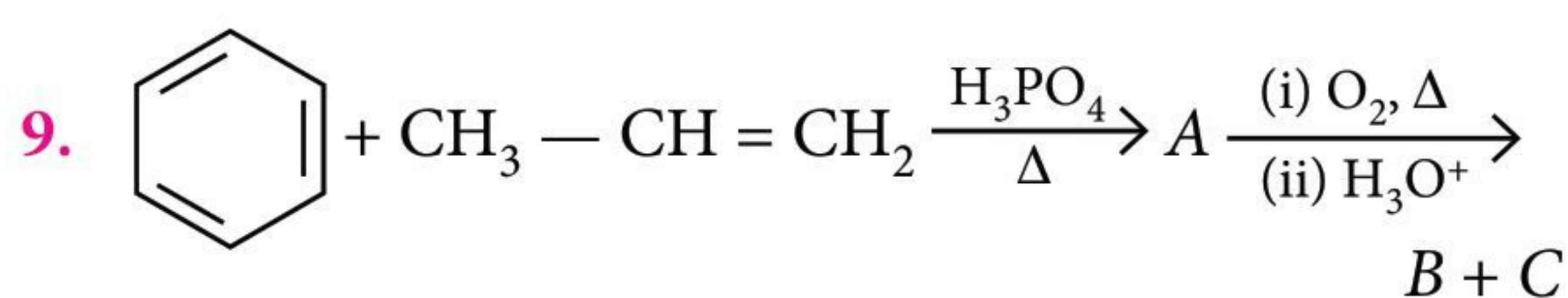
(a) $(\text{CH}_3)_2\text{CHCl} > \text{CH}_3\text{CH}_2\text{Cl} > \text{CH}_3\text{Cl} > (\text{CH}_3)_3\text{CCl}$
(b) $\text{CH}_3\text{Cl} > (\text{CH}_3)_2\text{CHCl} > \text{CH}_3\text{CH}_2\text{Cl} > (\text{CH}_3)_3\text{CCl}$
(c) $\text{CH}_3\text{Cl} > \text{CH}_3\text{CH}_2\text{Cl} > (\text{CH}_3)_2\text{CHCl} > (\text{CH}_3)_3\text{CCl}$
(d) $\text{CH}_3\text{CH}_2\text{Cl} > \text{CH}_3\text{Cl} > (\text{CH}_3)_2\text{CHCl} > (\text{CH}_3)_3\text{CCl}$

7. On freezing an aqueous solution of sugar, the solid that starts separating out is

(a) sugar
(b) ice
(c) solution with the same composition
(d) solution with a different composition.

8. Ice crystallises in a hexagonal lattice having volume of the unit cell as $132 \times 10^{-24} \text{ cm}^3$. If density of ice is 0.92 g cm^{-3} at a given temperature, then number of H_2O molecules per unit cell is

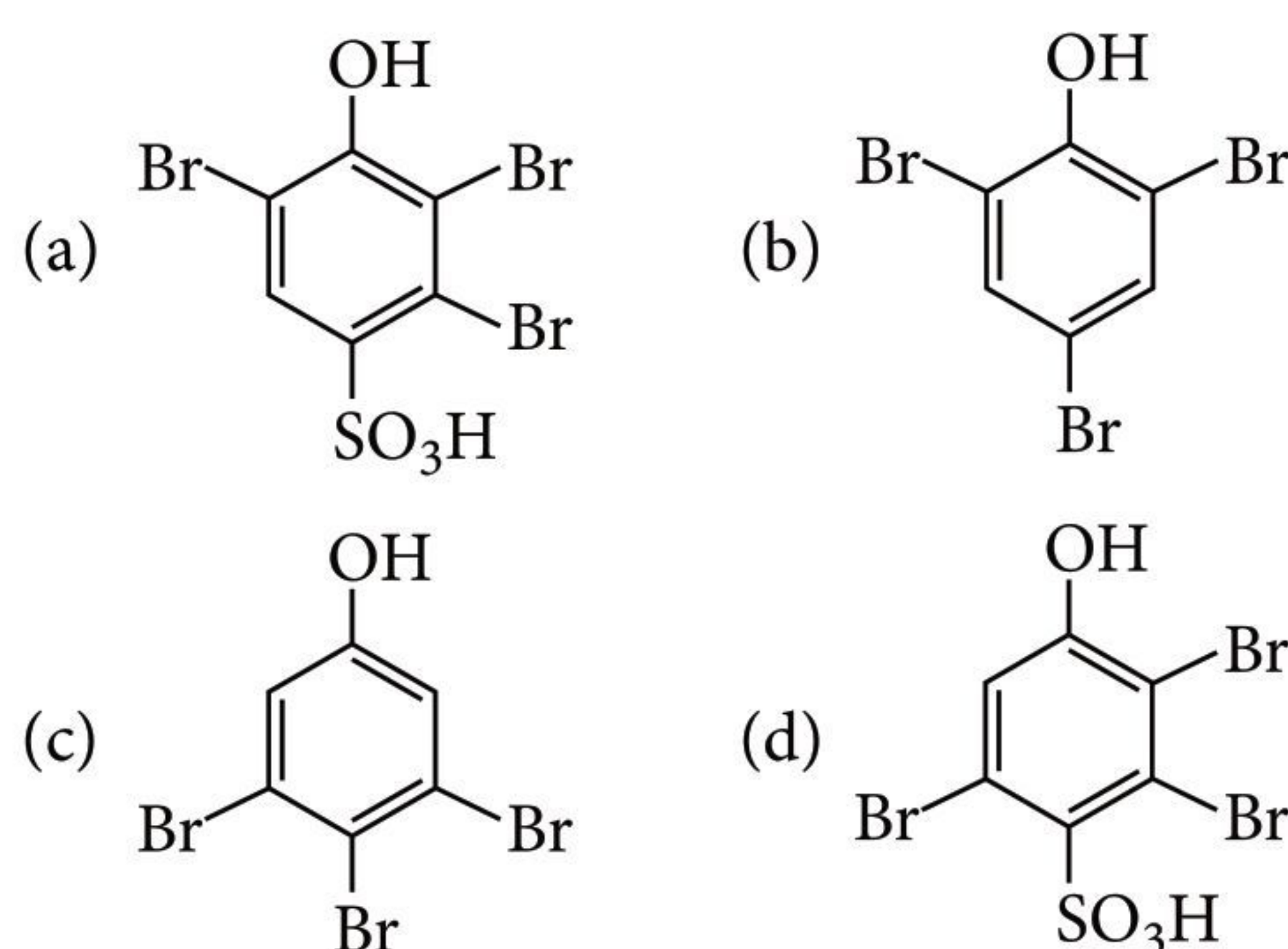
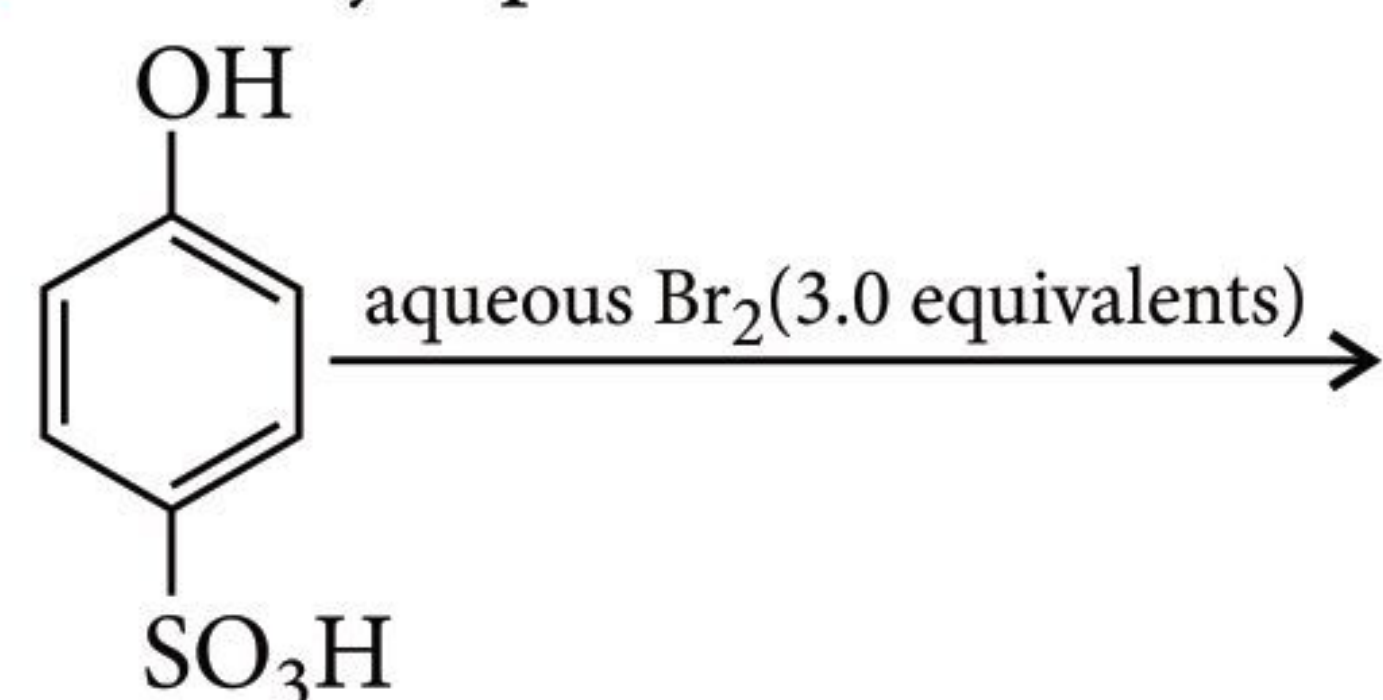
(a) 1 (b) 2 (c) 3 (d) 4



The products B and C are respectively

(a) phenol and acetic acid
(b) phenol and acetaldehyde
(c) benzoic acid and acetone
(d) phenol and acetone.

10. The major product of the following reaction is



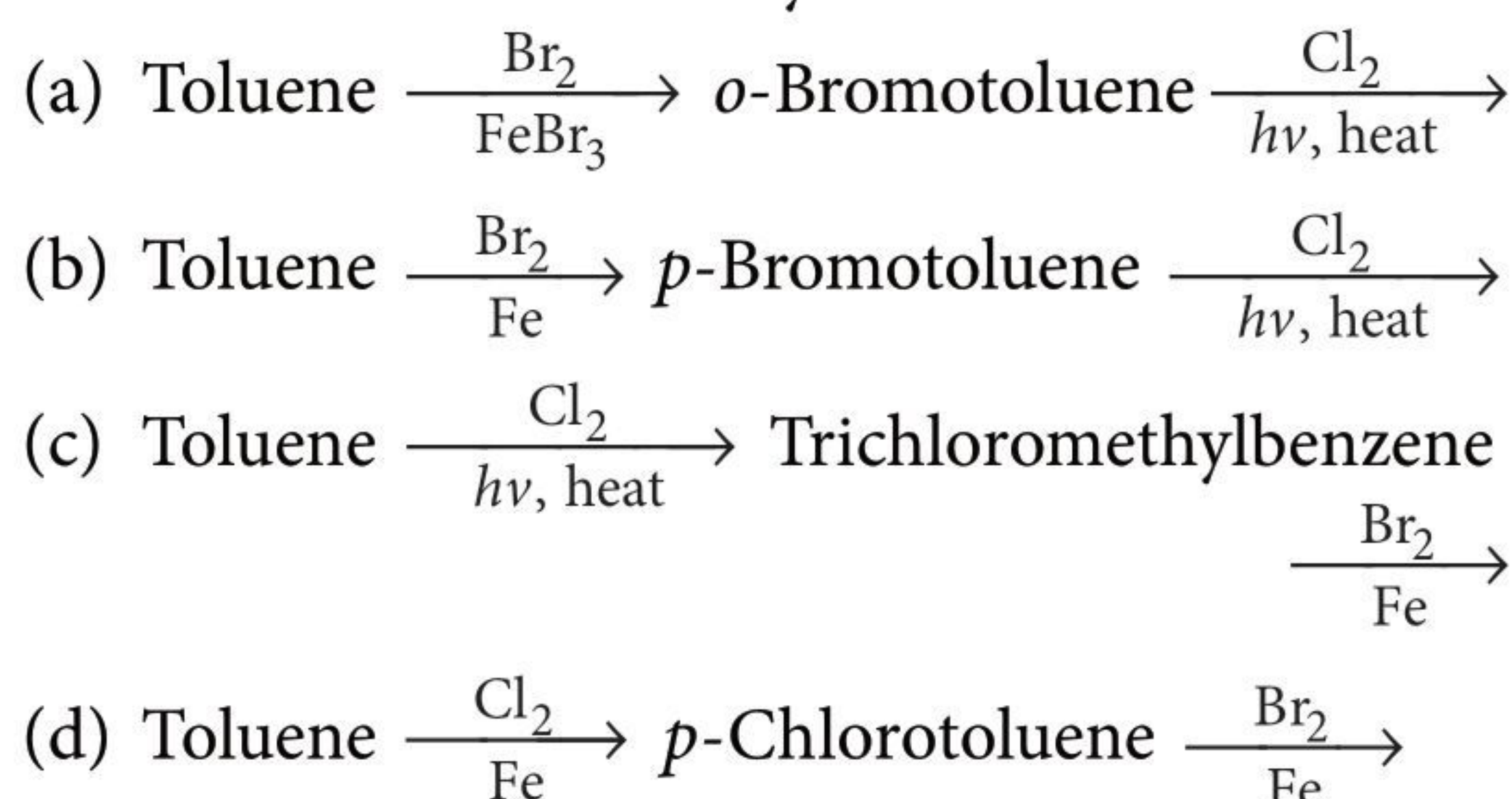
11. An element X (At. wt. = 80 g/mol) having fcc structure, calculate the number of unit cells in 8 g of X.

(a) $0.4 \times N_A$ (b) $0.1 \times N_A$
(c) $4 \times N_A$ (d) $N_A / 40$

12. Identify the correct sequence of increasing number of π -bonds in structures of the following molecules.

(I) $\text{H}_2\text{S}_2\text{O}_6$ (II) H_2SO_3
(III) $\text{H}_2\text{S}_2\text{O}_5$
(a) I, II, III (b) II, III, I
(c) II, I, III (d) I, III, II

13. Which of the following reactions will give 1-bromo-4-trichloromethylbenzene?



14. In nucleic acids, the nucleotides are linked to one another through

(a) hydrogen bond (b) peptide bond
(c) glycosidic linkage (d) phosphate groups.

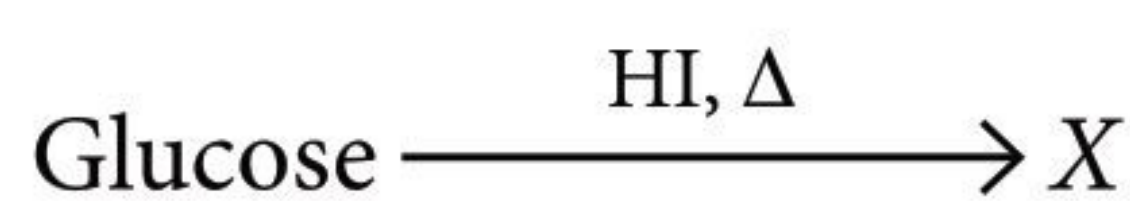
15. H_2S gas is used in qualitative analysis of inorganic cations. Its solubility in water at 1 atmospheric pressure is $0.195 \text{ mol kg}^{-1}$. Thus, Henry's law constant (in atm molal^{-1}) for H_2S is

(a) 2.628×10^{-4} (b) 5.128
(c) 0.185 (d) 3.826×10^3

16. Conversion of chlorobenzene into phenol involves

(a) NaOH at 623 K and 320 atmospheric pressure
(b) NaOH at 273 K and 100 atmospheric pressure
(c) NaNO_2 at 623 K and 100 atmospheric pressure
(d) NaNO_2 at 273 K and 320 atmospheric pressure.

17. Product (X) of the following reaction is



- (a) *n*-heptanoic acid
(b) 2-methylhexanoic acid
(c) *n*-hexane (d) 2-methylhexane.
18. A solution containing 1.8 g of a compound (empirical formula CH_2O) in 40 g of water is observed to freeze at -0.465°C . The molecular formula of the compound is (K_f of water = $1.86 \text{ kg K mol}^{-1}$)
(a) $\text{C}_2\text{H}_4\text{O}_2$ (b) C_3H_6
(c) $\text{C}_4\text{H}_8\text{O}_4$ (d) $\text{C}_6\text{H}_{12}\text{O}_6$
19. A metal crystallizes into two cubic phases, face centered cubic (*fcc*) and body centred cubic (*bcc*), whose unit cell lengths are 3.5 \AA and 3.0 \AA , respectively. The ratio of densities of *fcc* and *bcc* respectively are
(a) $1.65 : 1$ (b) $1.259 : 1$
(c) $1.175 : 1$ (d) $1.365 : 1$
20. Acidity of diprotic acids in aqueous solution increases in the order
(a) $\text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te}$ (b) $\text{H}_2\text{Se} < \text{H}_2\text{S} < \text{H}_2\text{Te}$
(c) $\text{H}_2\text{Te} < \text{H}_2\text{S} < \text{H}_2\text{Se}$ (d) $\text{H}_2\text{Se} < \text{H}_2\text{Te} < \text{H}_2\text{S}$
21. The synthesis of alkyl fluorides is best accomplished by
(a) Finkelstein reaction
(b) Swarts reaction
(c) free radical fluorination
(d) Sandmeyer's reaction.
22.
$$\begin{array}{c} \text{CHO} \\ | \\ (\text{CHOH})_4 \\ | \\ \text{CH}_2\text{OH} \end{array} \xrightarrow{\text{Acetic anhydride}} A$$

The number of oxygen atoms present in product A is
(a) 3 (b) 4 (c) 5 (d) 2
23. The osmotic pressure of a solution is given by the relation
(a) $\pi = RT/C$ (b) $\pi = CT/R$
(c) $\pi = RC/T$ (d) $\pi/C = RT$
24. The correct statement regarding, (i) HClO , (ii) HClO_2 , (iii) HClO_3 and (iv) HClO_4 , is/are
(a) the number of $\text{Cl}=\text{O}$ bonds in (ii) and (iii) together is two
(b) the number of lone pairs of electrons on Cl in (ii) and (iii) together is three
(c) the hybridization of Cl in (iv) is sp^2
(d) amongst (i) to (iv), the strongest acid is (i).

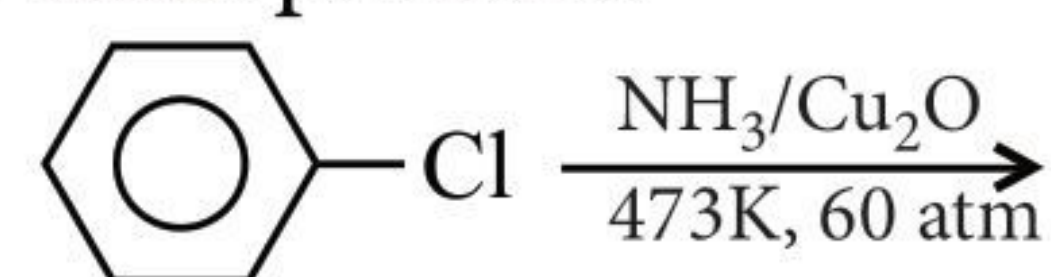
25. Hydrogen bonding for the base pairs of DNA is between

- (a) amide carbonyl and $-\text{NH}_2$ only
(b) amide N—H and cyclic amine nitrogen only
(c) alcoholic and carbonyl group only
(d) both (a) and (b).

SECTION - B

This section consists of 24 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation.

26. Two solutions of KNO_3 and CH_3COOH are prepared separately. Molarity of both is 0.1 M and osmotic pressures are p_1 and p_2 respectively. The correct relationship between the osmotic pressures is
(a) $p_1 = p_2$ (b) $p_1 > p_2$
(c) $p_2 > p_1$ (d) $\frac{p_1}{p_1 + p_2} \neq \frac{p_2}{p_1 + p_2}$
27. Solid CO_2 is an example of
(a) covalent solid (b) metallic solid
(c) molecular solid (d) ionic solid.
28. The incorrect statement(s) about O_3 is
(a) O—O bond lengths are equal
(b) O_3 is diamagnetic in nature
(c) thermal decomposition of O_3 is endothermic
(d) O_3 has a bent structure.
29. Predict the main product.



- (a) Phenyl cyanide (b) Nitrophenol
(c) Aniline (d) Hydroxylamine
30. The correct statement regarding defects in crystalline solids is
(a) Frenkel defects decrease the density of crystalline solids
(b) Frenkel defect is a dislocation defect
(c) Frenkel defect is found in halides of alkaline metals
(d) Schottky defects have no effect on the density of crystalline solids.
31.
$$\text{HCl} \xrightleftharpoons[4]{1} \text{Cl}_2 \xrightleftharpoons[3]{2} \text{KClO}_3$$

In the above sequence of reactions, the steps 2 and 3 require following reagents respectively?
(a) NaOH , I_2 (b) HCl , I_2
(c) KOH , I_2 (d) KOH , O_2

32. The S_N1 reactivity of the following halides will be in the order

- (i) $(CH_3)_3CBr$ (ii) $(C_6H_5)_2CHBr$
 (iii) $(C_6H_5)_2C(CH_3)Br$ (iv) $(CH_3)_2CHBr$
 (v) C_2H_5Br

- (a) $(v) > (iv) > (i) > (ii) > (iii)$
 (b) $(ii) > (i) > (iii) > (v) > (iv)$
 (c) $(i) > (iii) > (v) > (ii) > (iv)$
 (d) $(iii) > (ii) > (i) > (iv) > (v)$

33. A metal crystallizes in body-centred cubic structure. The correct statement amongst the following is

- (a) each atom touches 4 atoms in its own layer and 4 each in the layers immediately above and below it
 (b) each atom touches 6 atoms each in the layers immediately above and below it and none in its own layer
 (c) each atom touches 4 atoms each in the layers immediately above and below it and none in its own layer
 (d) each atom touches 8 atoms each in the layers immediately above and below it and none in its own layer.

34. The vapour pressure of acetone at $20^\circ C$ is 185 torr. When 1.2 g of a non-volatile substance was dissolved in 100 g of acetone at $20^\circ C$, its vapour pressure was 183 torr. The molar mass ($g\ mol^{-1}$) of the substance is

- (a) 128 (b) 488 (c) 32 (d) 64

35. Which of the following sets of bases are present both in DNA and RNA?

- (a) Adenine, uracil, thymine
 (b) Adenine, guanine, cytosine
 (c) Adenine, guanine, uracil
 (d) Adenine, guanine, thymine

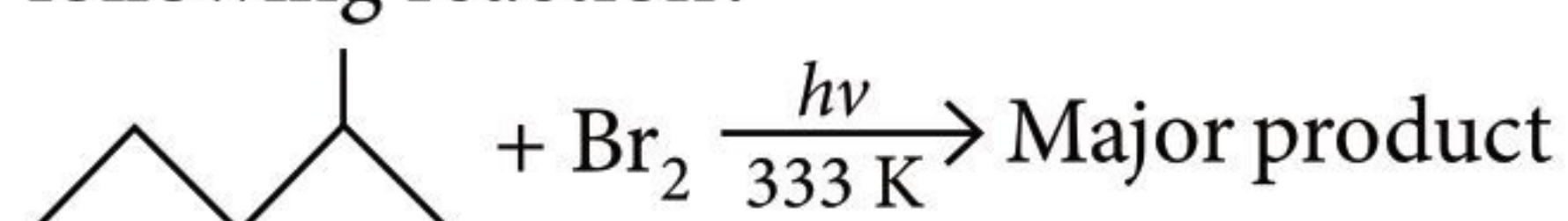
36. In alkaline solution $HXeO_4^-$ disproportionates to

- (a) XeO_6^{4-} and Xe (b) XeO_4^{2-} and XeO_3
 (c) XeO_3 and Xe (d) XeO_6^{4-} and XeO_3

37. $C_2H_5OC_2H_5$ absorbs oxygen in presence of light to form

- (a) acetic acid (b) ether suboxide
 (c) ether peroxide (d) ethyl alcohol.

38. Which of the following is the major product of the following reaction?



- (a) 3-Bromo-2-methylpentane
 (b) 2-Bromo-2-methylpentane
 (c) 1-Bromo-2-methylpentane
 (d) 4-Bromo-2-methylpentane

39. The vacant space in bcc lattice unit cell is

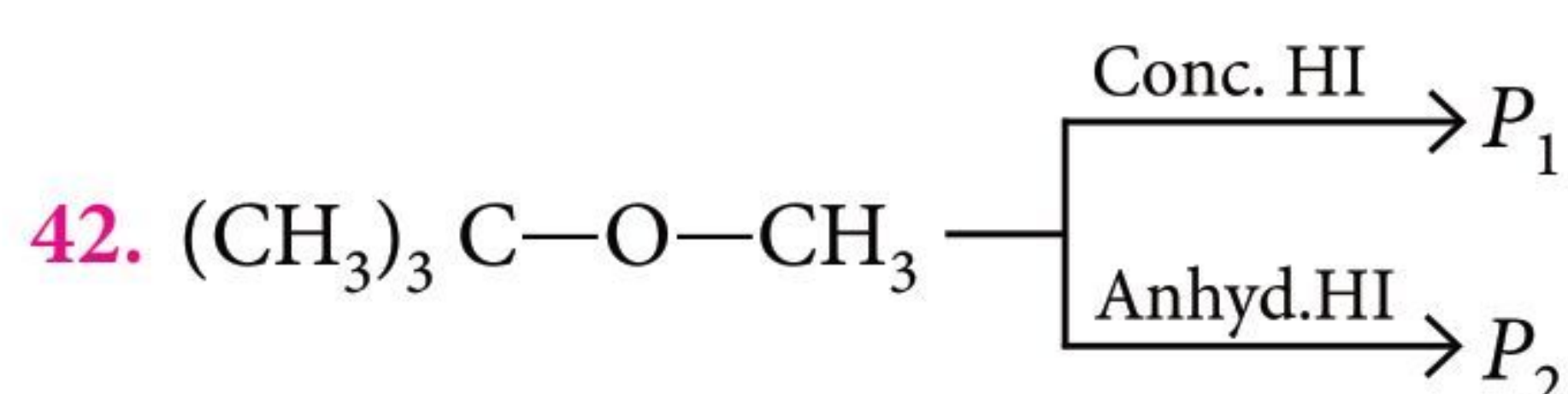
- (a) 48% (b) 23% (c) 32% (d) 26%

40. A mixture contains three amino acids A ($pI = 3.2$), B ($pI = 5.7$) and C ($pI = 9.7$). When it is subjected to electrophoresis at $pH\ 7.7$, in which direction will each component of the mixture move?

- (a) A to anode, B and C to cathode.
 (b) A to anode, B no movement, C to cathode.
 (c) A and B to anode and C to cathode.
 (d) A to cathode, B no movement, C to anode.

41. Which of the following is/are important secondary structural feature(s) in large peptides and proteins?

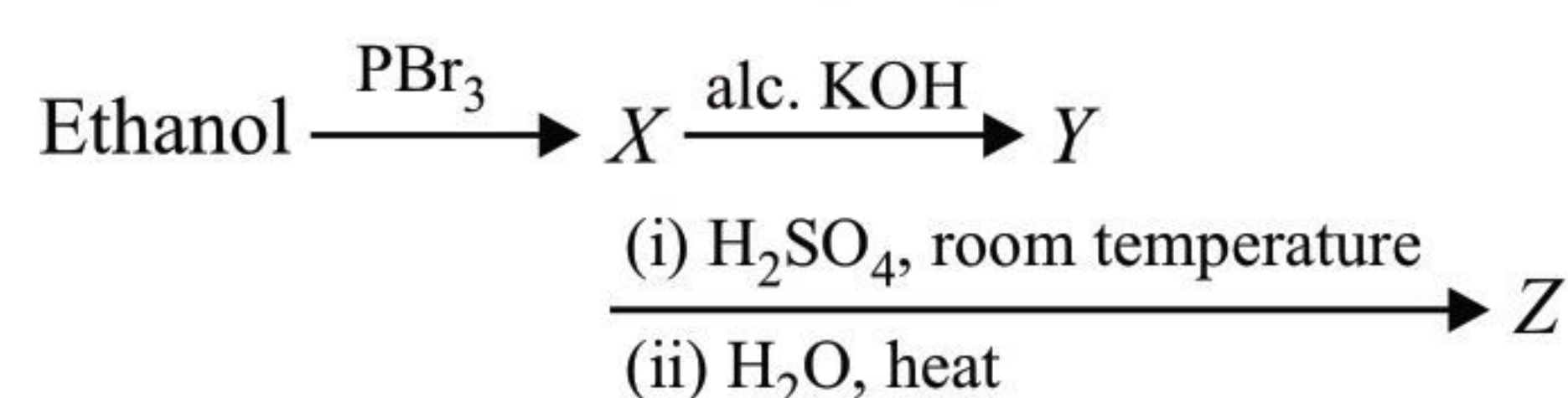
- (I) The α -helix (II) The β -turn
 (III) Chair conformations
 (IV) The β -pleated sheet
 (a) I only (b) III only
 (c) II and III only (d) I, II and IV only



The products P_1 and P_2 are respectively

- (a) $(CH_3)_3COH + CH_3I$ and $(CH_3)_3CI + CH_3OH$
 (b) $(CH_3)_3CI + CH_3OH$ and $(CH_3)_3COH + CH_3I$
 (c) $(CH_3)_3CI + CH_3OH$ in both cases
 (d) CH_3I and $(CH_3)_3COH$ in both cases.

43. Consider the following sequence of reaction :



the product Z is

- (a) $CH_3CH_2-O-CH_2-CH_3$
 (b) $CH_3-CH_2-O-SO_3H$
 (c) CH_3CH_2OH
 (d) $CH_2=CH_2$

44. Calculate the mass of a non-volatile solute (molar mass = $40\ g\ mol^{-1}$) which should be dissolved in 114 g octane to reduce its vapour pressure to 80%.

- (a) 20 g (b) 10 g (c) 30 g (d) 45 g

45. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : Henry's law and Raoult's law are not independent, *i.e.*, one can be derived from the other.

Reason : The partial pressure is directly proportional to the mole fraction of the concerned species for ideal solutions.

Select the most appropriate answer from the options given below.

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true but R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) A is false but R is true.

46. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : The aqueous solution of XeF_2 is a powerful oxidising agent.

Reason : Hydrolysis of XeF_2 is slow in dilute acid but rapid in basic solution.

Select the most appropriate answer from the options given below.

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true but R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) A is false but R is true.

47. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : Graphite is an example of tetragonal crystal system.

Reason : For a tetragonal system, $a = b \neq c$ and $\alpha = \beta = \gamma = 90^\circ$.

Select the most appropriate answer from the options given below.

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true but R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) A is false but R is true.

48. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : Alkyl iodides darken on standing.

Reason : Alkyl iodides are prepared by Finkelstein reaction.

Select the most appropriate answer from the options given below.

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true but R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) A is false but R is true.

49. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : The acidity of alcohols follows the order : $1^\circ > 2^\circ > 3^\circ$

Reason : +I-effect of the additional alkyl groups favours the cleavage of O—H bond.

Select the most appropriate answer from the options given below :

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true but R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) A is false but R is true.

SECTION - C

This section consists of 6 multiple choice questions with an overall choice to attempt any 5. In case more than desirable number of questions are attempted, ONLY first 5 will be considered for evaluation.

50. Match the entries of List I with appropriate entries of List II and select the correct answer using the codes given below the lists :

List I	List II
P. Glycosidic linkage	1. Globular protein
Q. Insulin	2. Connects two monosaccharide units
R. Peptide bond	3. Monomeric unit of nucleic acids
S. Nucleotide	4. Connects two amino acid units

P	Q	R	S
(a) 4	3	2	1
(b) 3	4	1	2
(c) 2	1	4	3
(d) 1	2	3	4

51. Which of the following is not correct analogy?

- (a) Orthorhombic : $a \neq b \neq c$; $\alpha = \beta = \gamma = 90^\circ$:: Tetragonal : $a = b \neq c$; $\alpha = \beta = \gamma = 90^\circ$
- (b) Hexagonal : Graphite :: Monoclinic :

$$(c) \text{ Linear : } \frac{r^+}{r^-} = 0.155 - 0.225 :: \text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$$

$$\text{Octahedral : } \frac{r^+}{r^-} = 0.414 - 0.732$$

(d) Frenkel defect : ZnS :: Metal excess defect : ZnO

52. Complete the following analogy :

$$\Delta H_{\text{mix}} > 0 ; \Delta V_{\text{mix}} > 0 : A :: \Delta H_{\text{mix}} < 0, \Delta V_{\text{mix}} < 0 : B$$

- (a) A : Positive deviation B : Ideal solution
- (b) A : Positive deviation B : Negative deviation
- (c) A : Negative deviation B : Positive deviation
- (d) A : Ideal solution B : Negative deviation

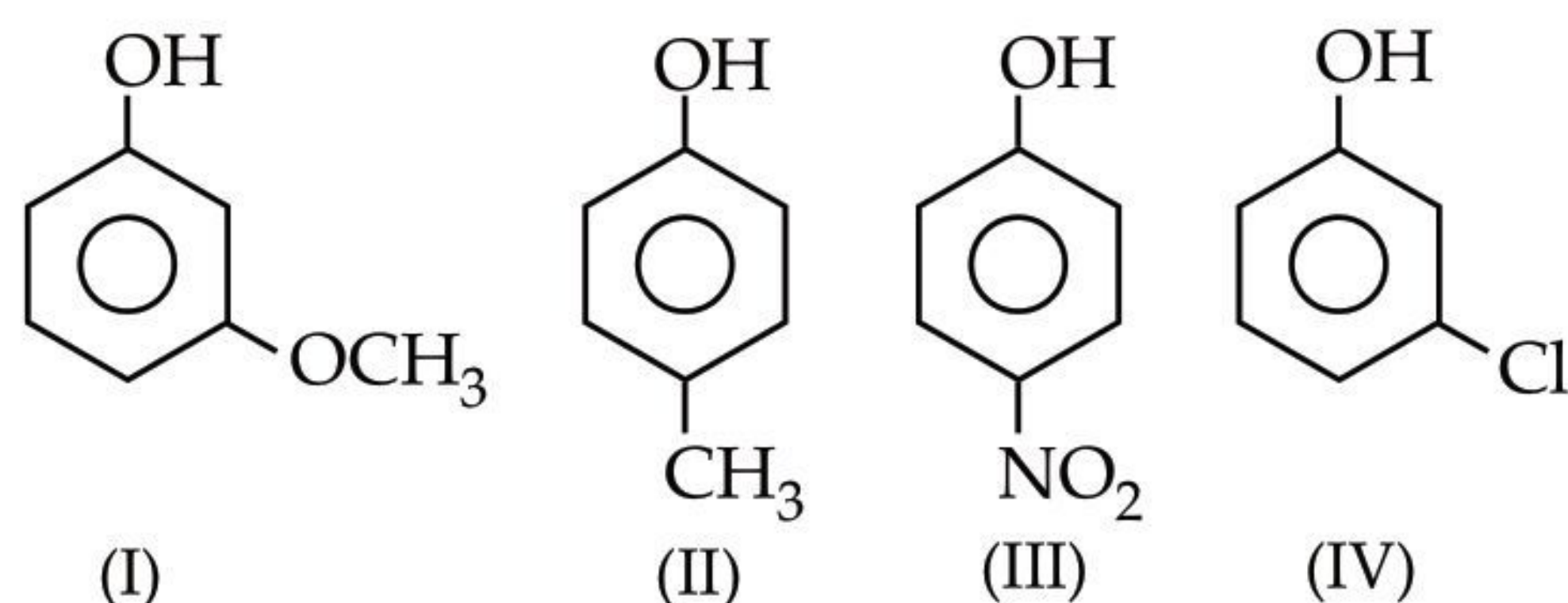
Read the passage given below and answer the following questions 53-55.

Both alcohols and phenols are acidic in nature, but phenols are more acidic than alcohols. Acidic strength of alcohols mainly depends upon the inductive effect. Acidic strength of phenols depends upon a combination of both inductive effect and resonance effects of the substituent and its position on the benzene ring. Electron withdrawing groups increases the acidic strength of phenols whereas electron donating groups decreases the acidic strength of phenols. Phenol is a weaker acid than carboxylic acid.

53. Phenols are highly acidic as compared to alcohols due to

- the higher molecular mass of phenols
- the stronger hydrogen bonds in phenols
- alkoxide ion is a strong conjugate base
- phenoxide ion is resonance stabilised.

54. The correct decreasing order of pK_a value is



- $II > IV > I > III$
- $IV > II > III > I$
- $III > II > IV > I$
- $IV > I > II > III$

55. The compound that does not liberate CO_2 , on treatment with aqueous sodium bicarbonate solution is

- benzoic acid
- benzenesulphonic acid
- salicylic acid
- carbolic acid.

SOLUTIONS

1. (d) : Rhombic sulphur consist of orthorhombic geometry ($a \neq b \neq c$, $\alpha = \beta = \gamma = 90^\circ$).

2. (b) : $C + 2H_2SO_4(\text{conc.}) \longrightarrow CO_2 + 2SO_2 + 2H_2O$

3. (c) : Catenation tendency is higher in phosphorus when compared with other elements of the same group.

4. (c)

5. (a) : $C_4H_{10}O \xrightarrow{\text{excess of HI}}$ only RI

Since, the compound ($C_4H_{10}O$) does not react with sodium, oxygen must be in the form of ether (ROR). Further, since a single alkyl halide is formed, the two alkyl groups must be same, hence ether is $C_2H_5OC_2H_5$.

6. (c) : Reactivity in $S_N2 \propto \frac{1}{\text{Steric hindrance}}$

Thus, the correct order of reactivity towards S_N2 reaction is :



7. (b) : When the solute is solid, it is solvent that freezes.

8. (d) : Volume = $132 \times 10^{-24} \text{ cm}^3$

Density = 0.92 g cm^{-3}

Mass of unit cell = Volume \times Density

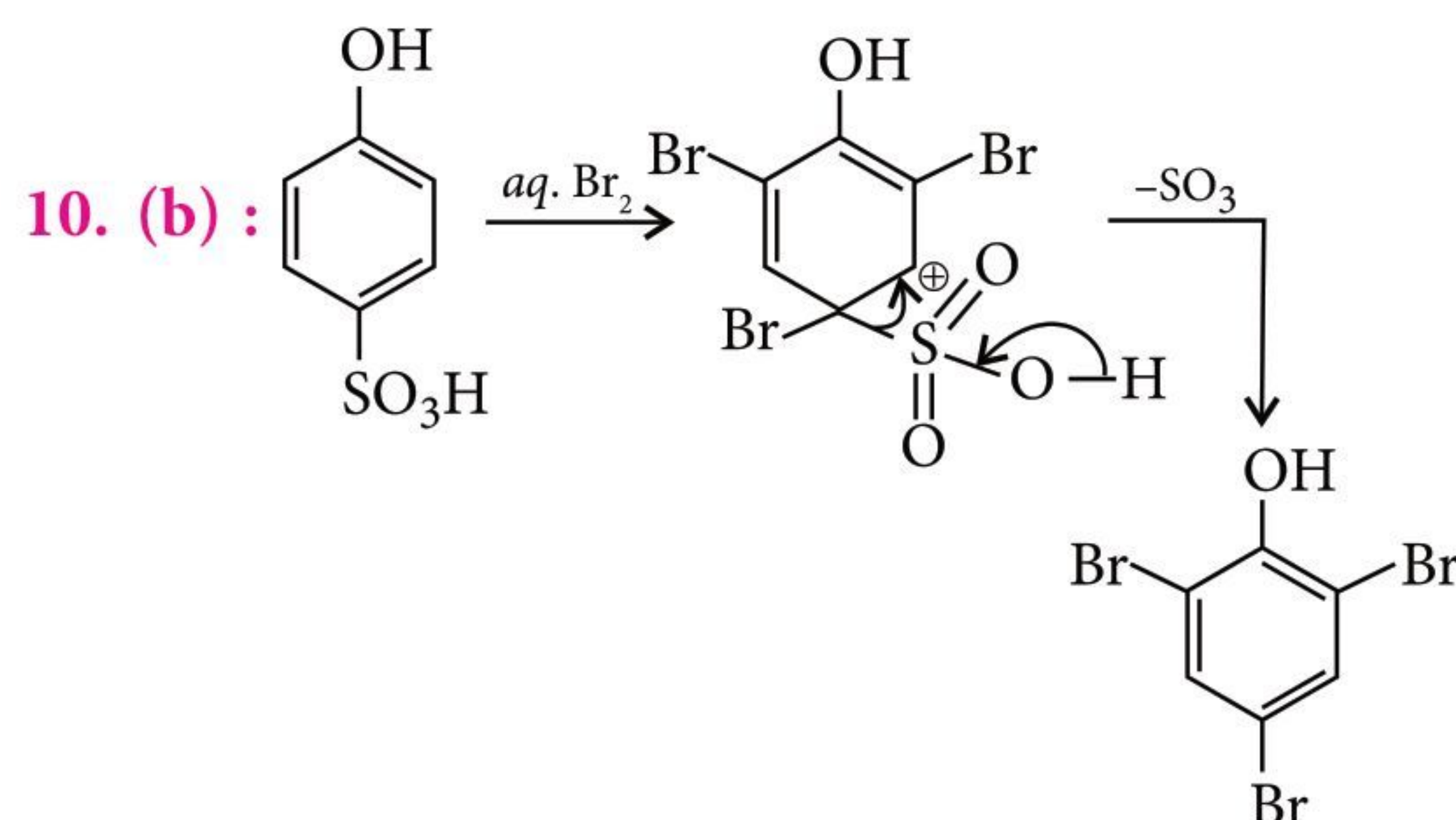
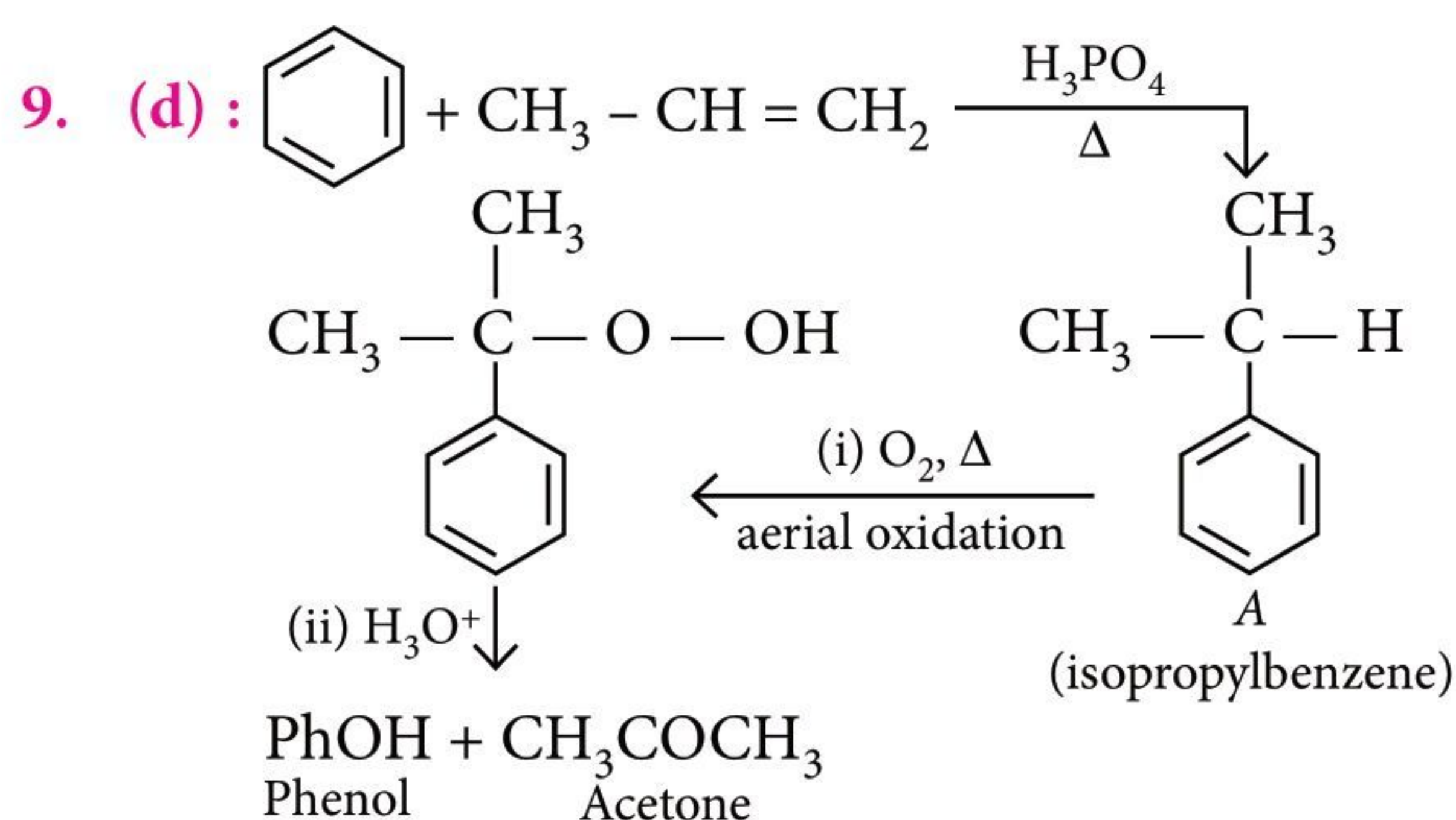
$$= 132 \times 10^{-24} \times 0.92 = 121.44 \times 10^{-24} \text{ g}$$

Molar mass of water = 18 g

$$\text{No. of moles of water} = \frac{121.44 \times 10^{-24}}{18} = 6.746 \times 10^{-24}$$

No. of water molecules per unit cell

$$= 6.746 \times 10^{-24} \times 6.022 \times 10^{23} = 40.6 \times 10^{-1} \approx 4$$



11. (d) : No. of atoms in the unit cell = 4 (fcc)

$$\text{No. of atom in 8 g of X} = \frac{8}{80} \times N_A = \frac{N_A}{10}$$

$$\therefore \text{No. of unit cell} = \frac{N_A}{10} \times \frac{1}{4} = \frac{N_A}{40}$$

12. (b) : $H_2S_2O_6$, $HO-\overset{\overset{O}{||}}{\underset{\underset{O}{||}}{S}}-\overset{\overset{O}{||}}{\underset{\underset{O}{||}}{S}}-OH$: 4 π -bonds ;

H_2SO_3 , $HO-\overset{\overset{O}{||}}{S}-OH$: one π -bond ;

$H_2S_2O_5$, $HO-\overset{\overset{O}{||}}{\underset{\underset{O}{||}}{S}}-\overset{\overset{O}{||}}{\underset{\underset{O}{||}}{S}}-OH$: 3 π -bonds.

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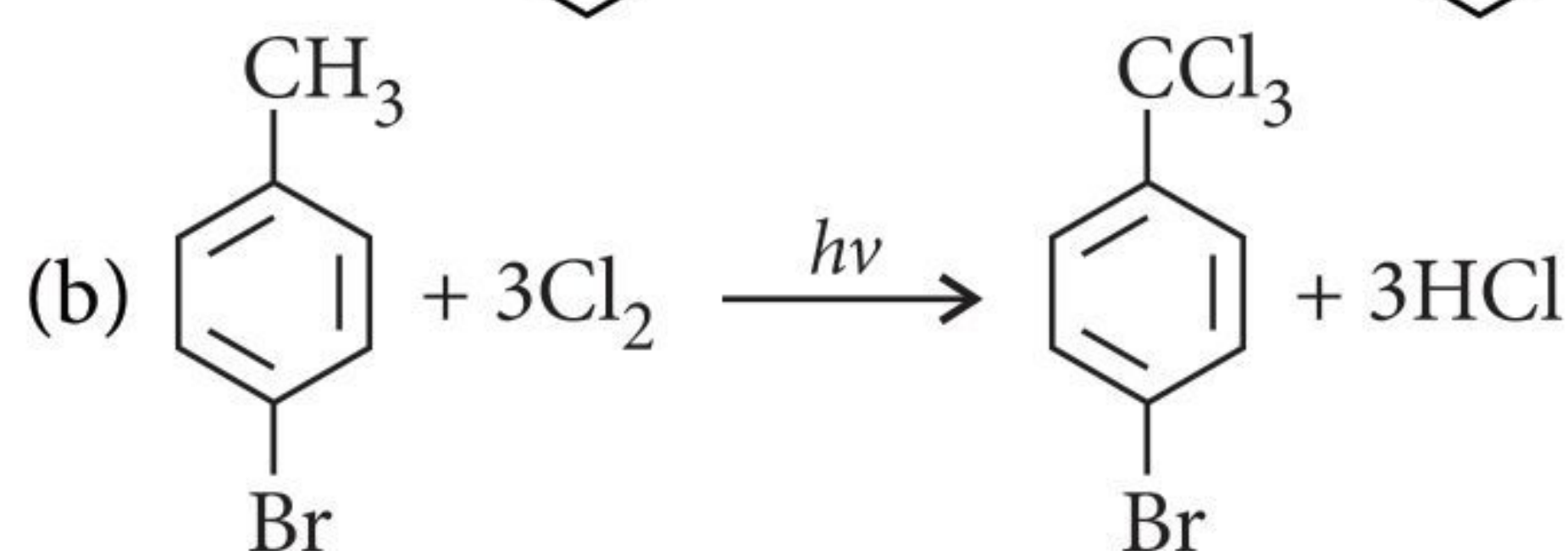
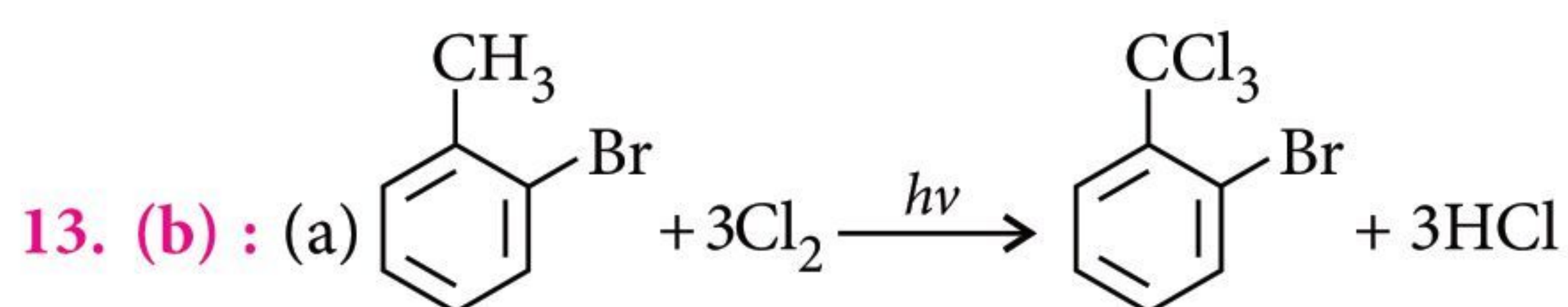
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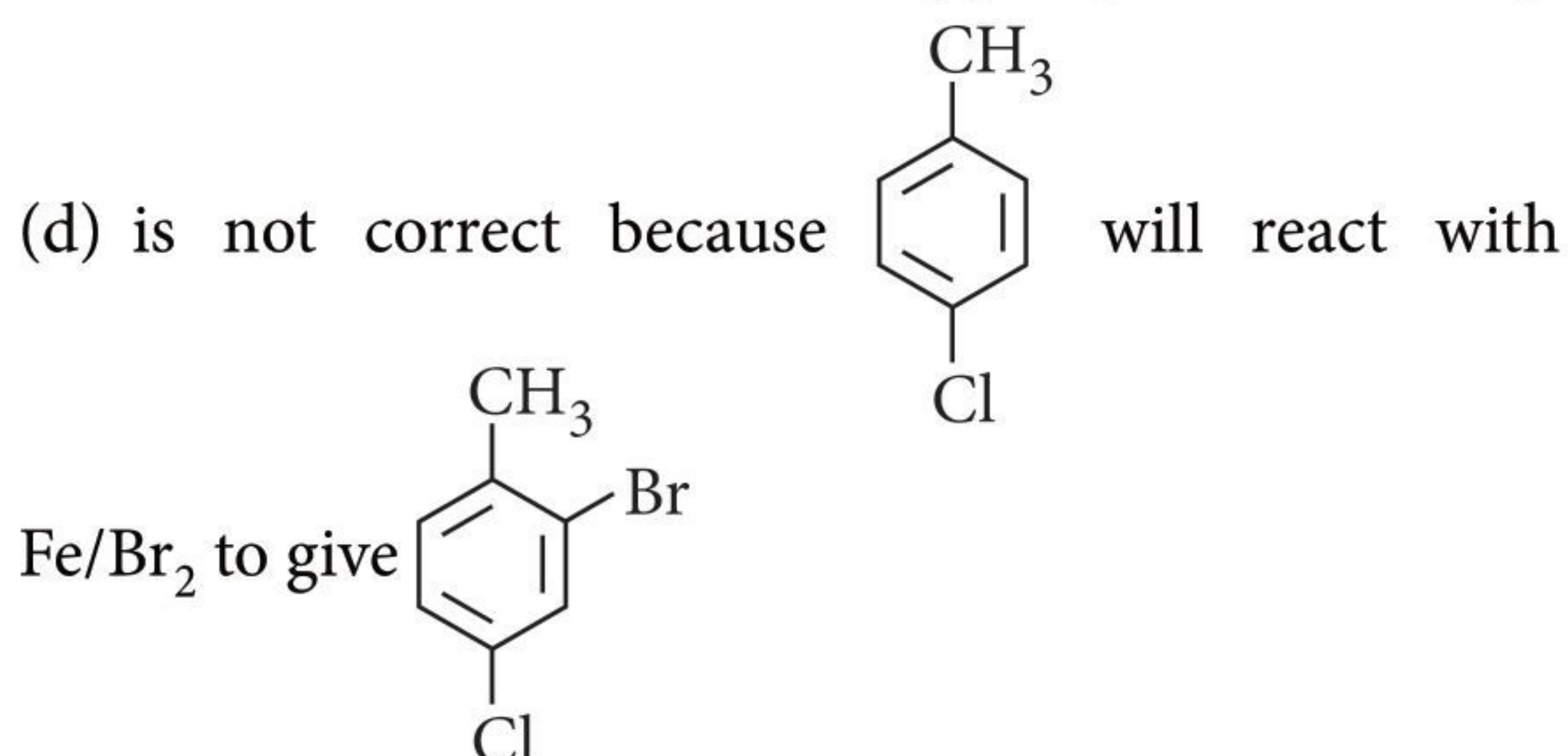
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(c) is not correct because $-\text{CCl}_3$ group is *m*-directing.

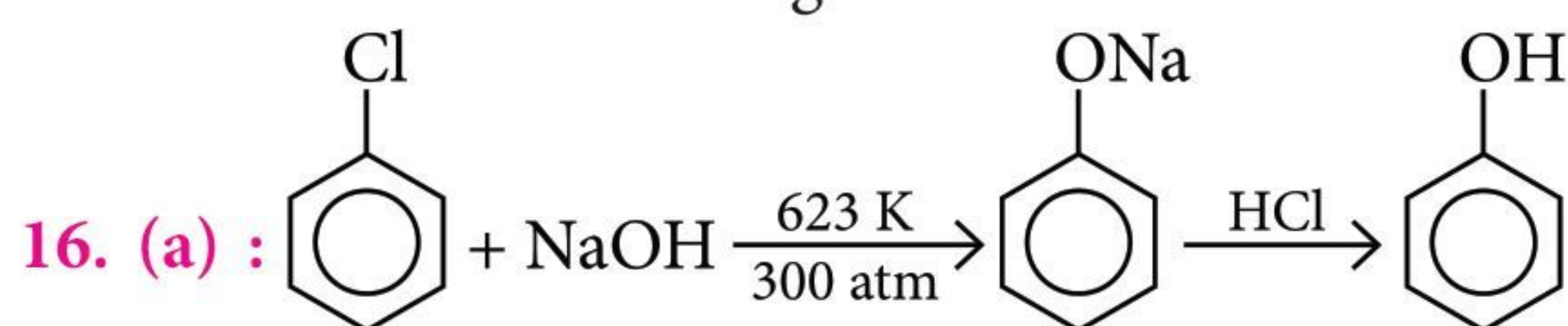


14. (d)

15. (b) : By Henry's law,

$p = K_H x = K_H S$ (where, S = solubility)

$$\therefore K_H = \frac{p}{S} = \frac{1 \text{ atm}}{0.195 \text{ mol kg}^{-1}} = 5.128 \text{ atm kg mol}^{-1}$$



17. (c) : Glucose on prolonged heating with HI gives *n*-hexane.

18. (d) : $\Delta T_f = K_f m$

$$0.465 = 1.86 \times \left[\frac{1.8/x}{40} \times 10^3 \right] \Rightarrow x = 180 \text{ g/mol}$$

(x = molecular wt. of the compound)

$$n = \frac{180}{\text{formula mass of } \text{CH}_2\text{O}} = \frac{180}{30} = 6$$

\therefore Thus, molecular formula, $(\text{CH}_2\text{O})_n = \text{C}_6\text{H}_{12}\text{O}_6$

19. (b) : Density in *fcc* = $\frac{z_1 \times \text{at.wt.}}{V_1 \times N_A}$

Density in *bcc* = $\frac{z_2 \times \text{at.wt.}}{V_2 \times N_A}$

$$\text{or } \frac{\text{Density (fcc)}}{\text{Density (bcc)}} = \frac{z_1}{z_2} \times \frac{V_2}{V_1} = \frac{4}{2} \times \frac{V_2}{V_1} \left[\begin{array}{l} \text{for fcc, } z_1 = 4 \\ \text{for bcc, } z_2 = 2 \end{array} \right]$$

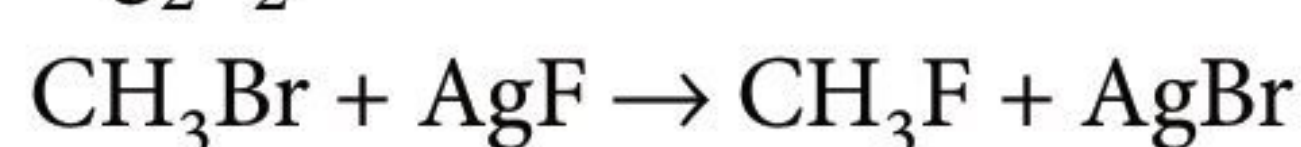
$$\text{Volume for fcc} = V_1 = a^3 = (3.5 \times 10^{-8})^3 \text{ cm}^3$$

$$\text{Volume for bcc} = V_2 = a^3 = (3.0 \times 10^{-8})^3 \text{ cm}^3$$

$$\therefore \frac{\text{Density (fcc)}}{\text{Density (bcc)}} = \frac{4 \times (3.0 \times 10^{-8})^3}{2 \times (3.5 \times 10^{-8})^3} = 1.259 \text{ or } 1.259 : 1$$

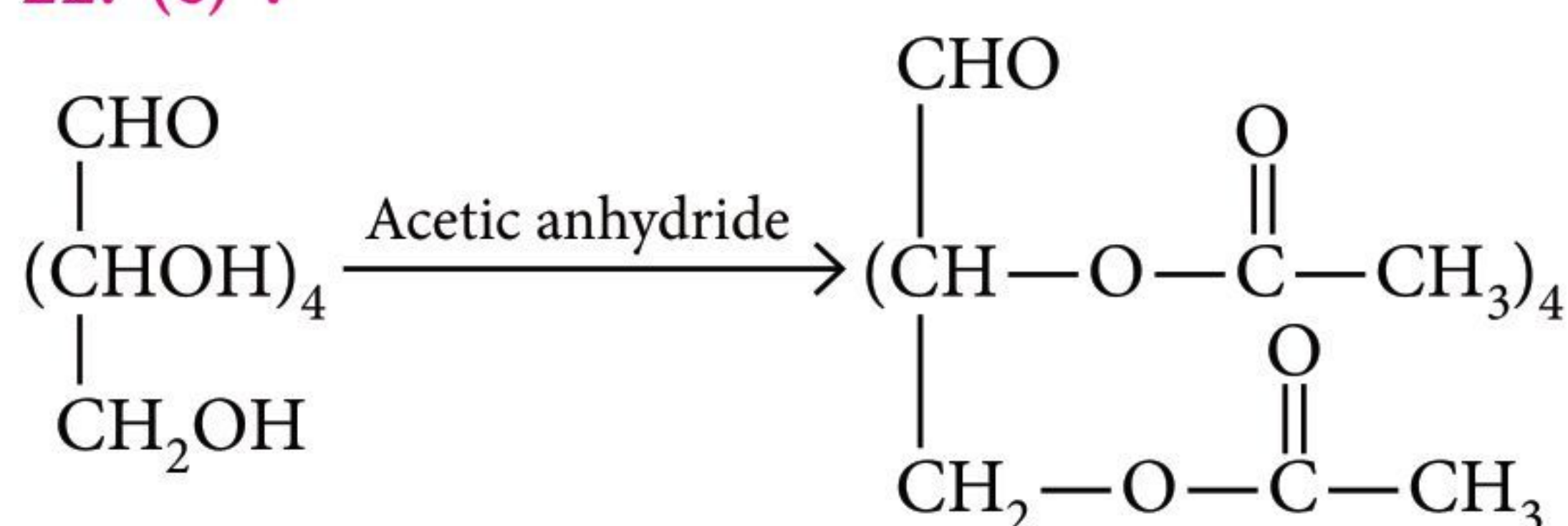
20. (a) : As the atomic size increases down the group, the bond length increases and the bond strength decreases and the cleavage of $M-H$ bond becomes easier thus, more will be the acidity. Hence, the correct order is : $\text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te}$.

21. (b) : Alkyl fluorides are more conveniently prepared indirectly by heating suitable chloro or bromoalkanes with inorganic fluorides, such as AsF_3 , SbF_3 , CoF_2 , AgF , Hg_2F_2 , etc.



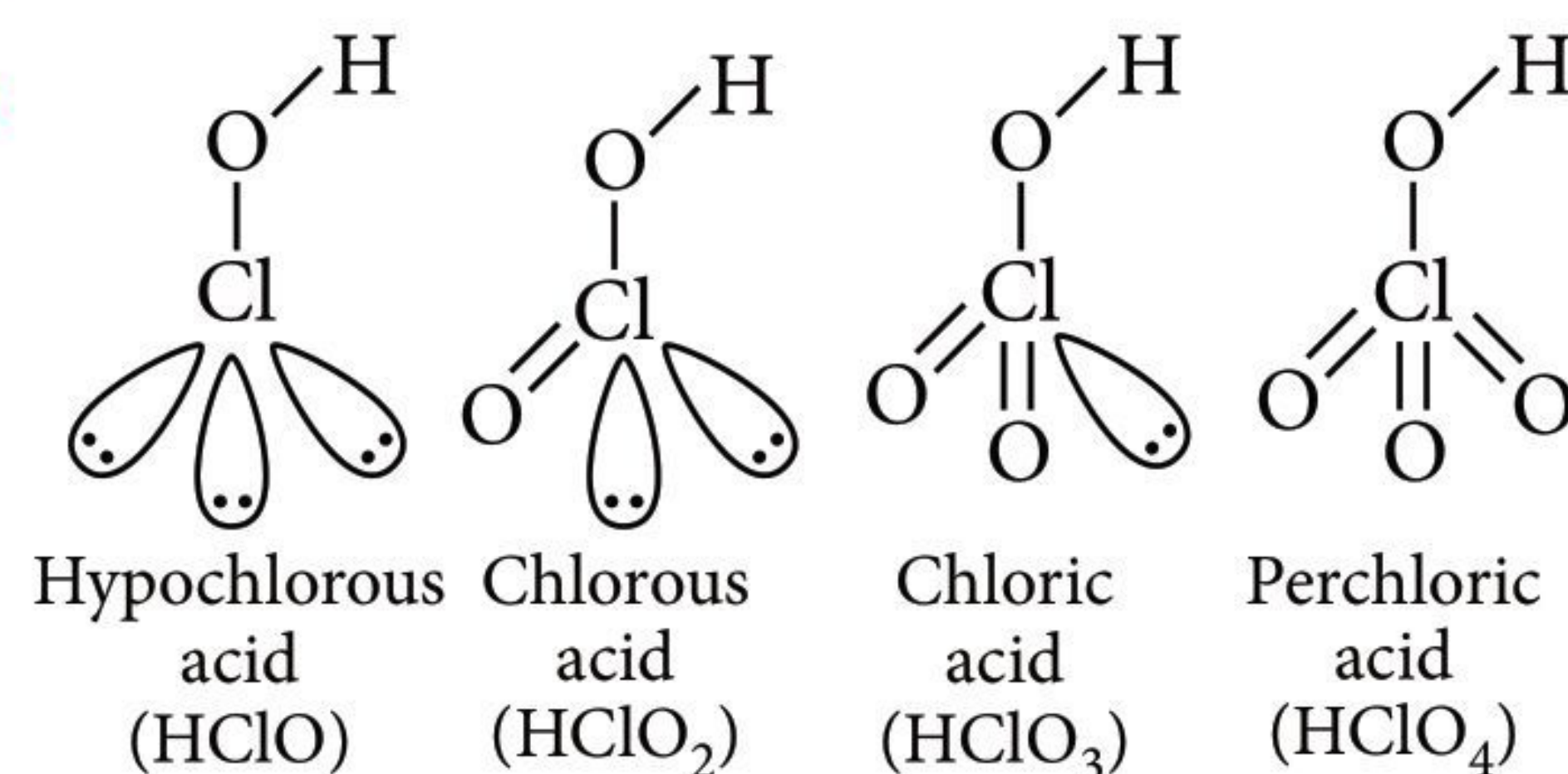
This reaction is called Swarts reaction.

22. (c) :



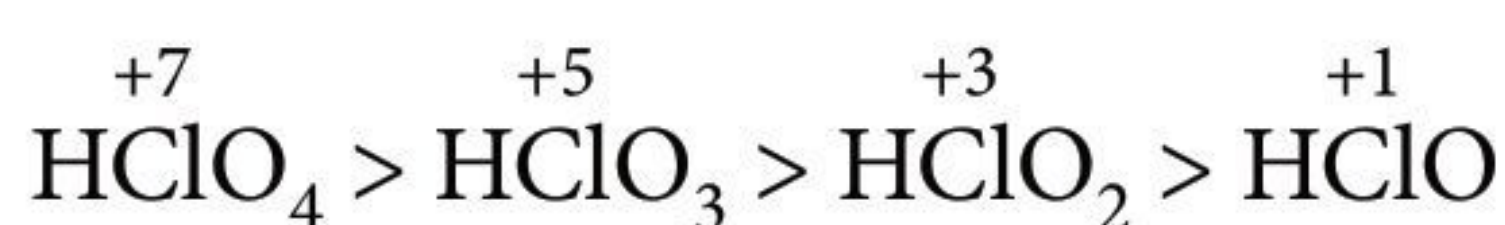
23. (d) : $\pi = CRT \Rightarrow \pi/C = RT$

24. (b) :



In all these oxoacids, Cl is sp^3 -hybridized.

Acid strength of oxoacids of the same halogen decreases with decrease in oxidation number of the halogen, e.g.,

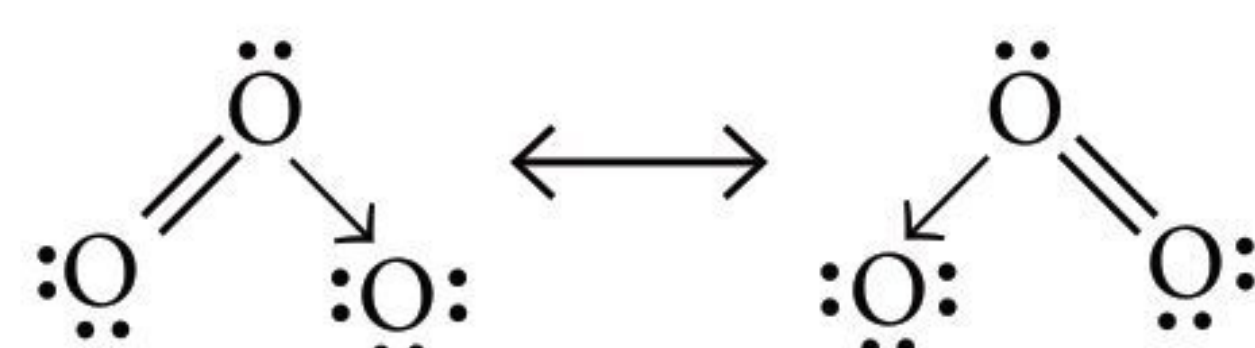


25. (d)

26. (b) : KNO_3 dissociates completely while CH_3COOH dissociates to a small extent hence, $p_1 > p_2$.

27. (c) : Solid carbon dioxide is an example of molecular solid in which CO_2 molecules are held by weak van der Waal's Forces.

28. (c) : On account of resonance, the two $\text{O}-\text{O}$ bond lengths are equal (1.28 Å). In O_3 , all the electrons are paired, so it is diamagnetic. It has a bent structure. Its formation is endothermic and hence, decomposition is exothermic.



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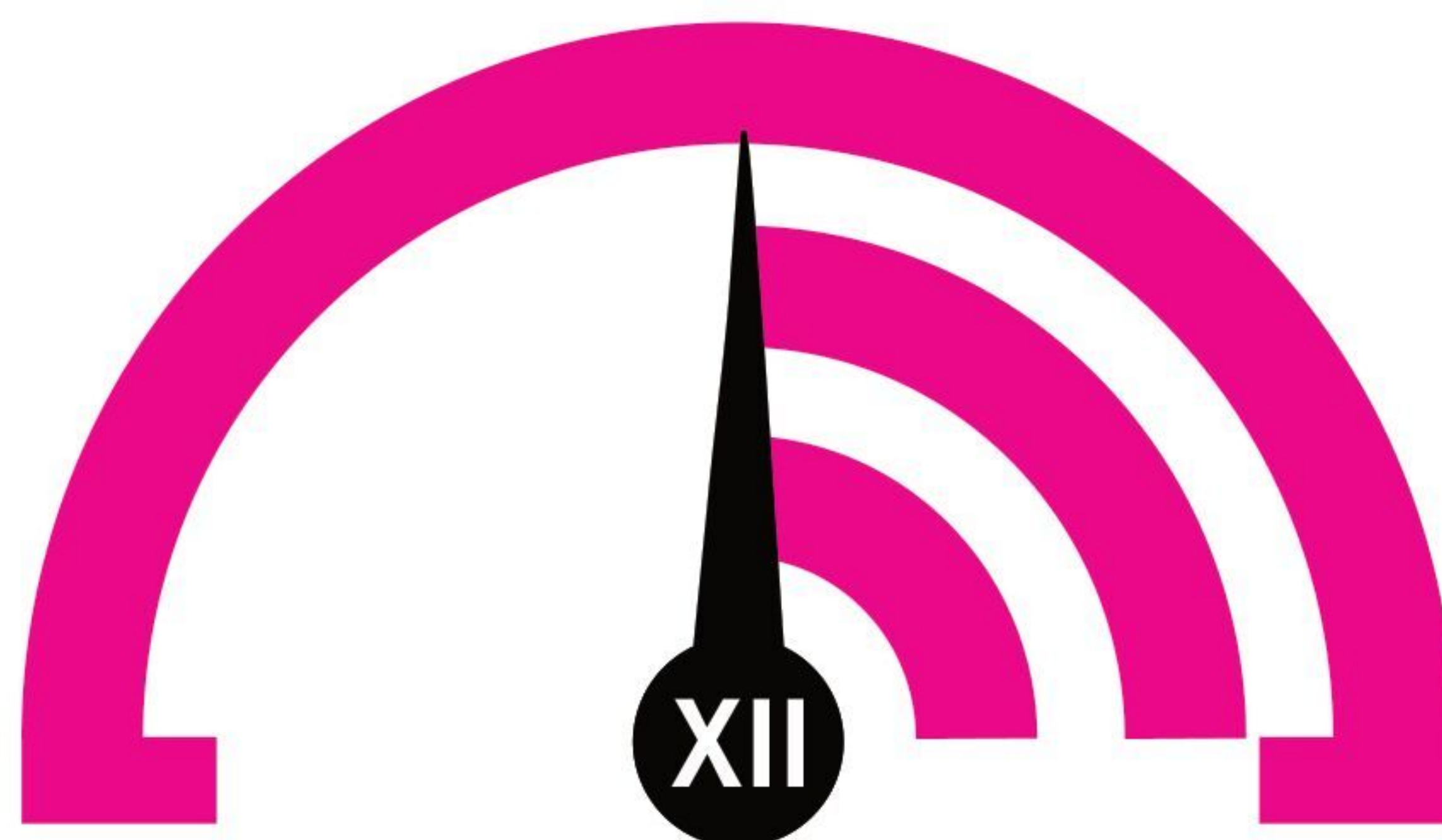
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$$\begin{array}{ccc} \text{(CH}_3\text{)}_2\text{CHBr} & > & \text{C}_2\text{H}_5\text{Br} \\ \text{(iv)} & & \text{(v)} \end{array}$$

82

MONTHLY TEST DRIVE



This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120

Polymers | Chemistry in Everyday Life

Time Taken : 60 Min.

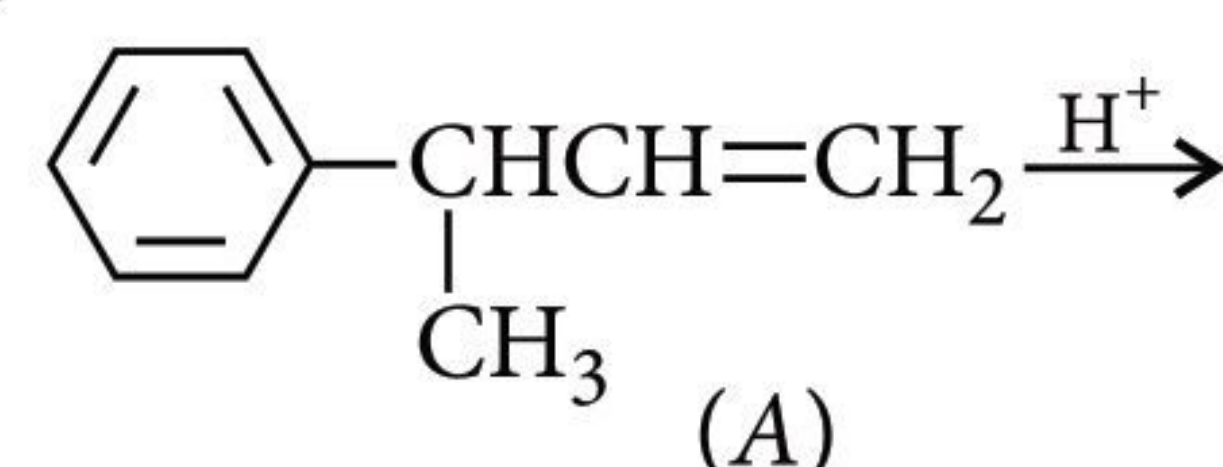
NEET

Only One Option Correct Type

- Identify the incorrect statement.
 - Bakelite and urea-formaldehyde resins are elastomers.
 - Polyamides like nylon 6, nylon 6,6 are the examples of fibres.
 - Polystyrene, polyvinyl and polythene are thermoplastic polymers.
 - Thermoplastic polymers have intermolecular forces in between elastomers and fibres.
- Which of the following substances is used as an antiseptic as well as a disinfectant?
 - Iodine
 - H_2O_2
 - Phenol
 - Dettol
- The example of cationic surfactant is
 - $\text{C}_{18}\text{H}_{37}\text{NH}_2$
 - $\text{C}_{16}\text{H}_{33}\text{N}(\text{CH}_3)_3\text{Cl}$
 - $\text{RC}_6\text{H}_4\text{SO}_3\text{Na}$
 - $\text{C}_{16}\text{H}_{33}\text{C}_6\text{H}_4\text{NHCl}$
- Which of the following can possibly be used as an analgesic without causing addiction?
 - Morphine
 - N*-acetyl-*para*-aminophenol
 - Diazepam
 - None of these
- Which of the following is a polymer of three different monomers?
 - ABS
 - SBR
 - NBR
 - Nylon-2-nylon-6
- The detergent which is used as a germicide is
 - sodium lauryl sulphate
 - cetyltrimethylammonium chloride

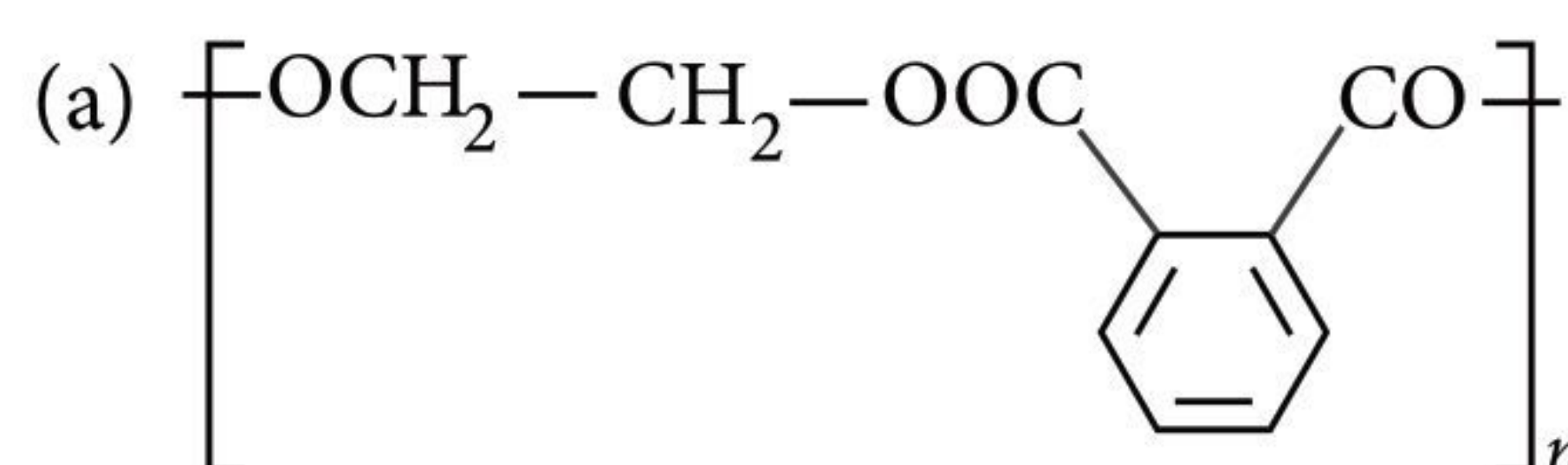
- lauryl alcohol ethoxylate
- sodium-2-dodecylbenzenesulphonate.

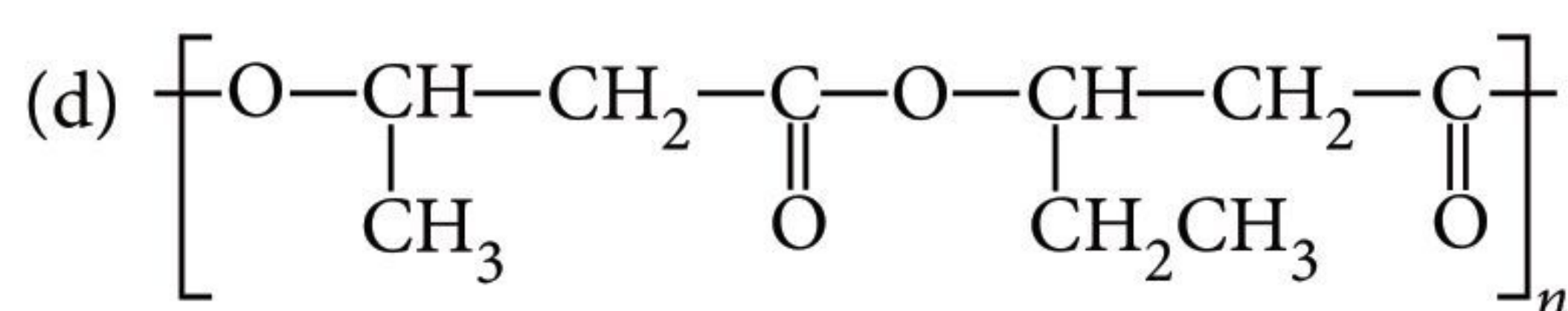
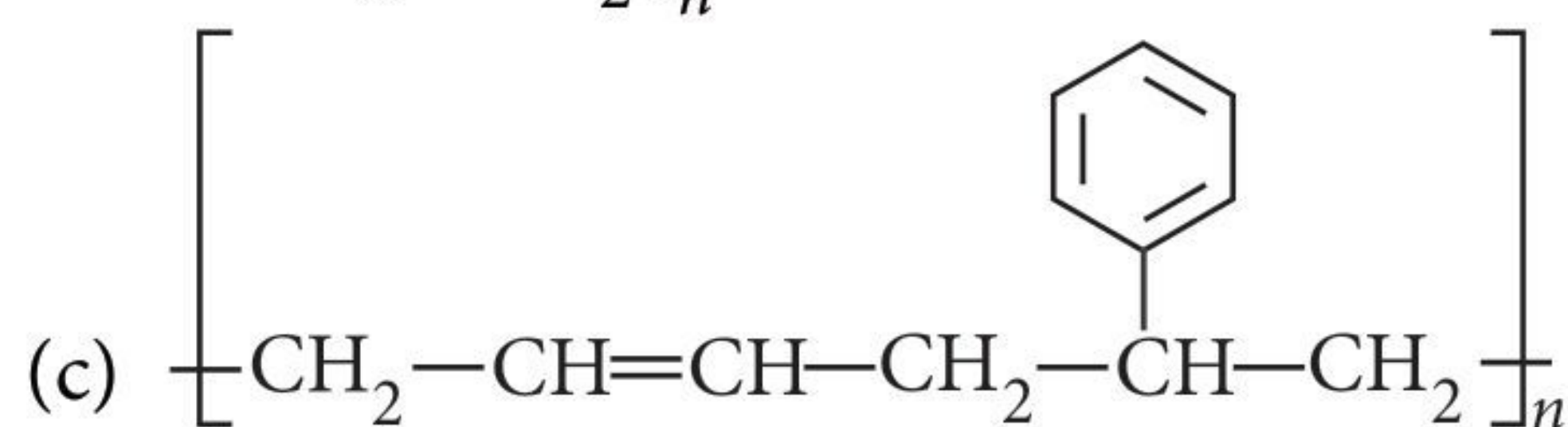
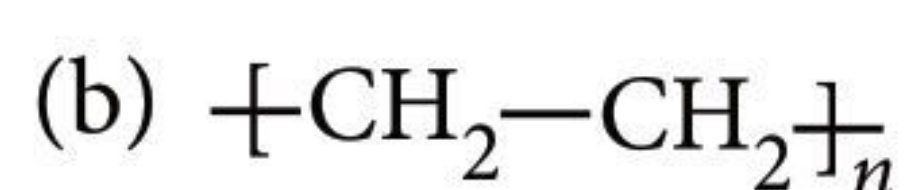
- Which of the following sets of reactants is used for the preparation of paracetamol from phenol?
 - HNO_3 , H_2/Pd , $(\text{CH}_3\text{CO})_2\text{O}$
 - H_2SO_4 , H_2/Pd , $(\text{CH}_3\text{CO})_2\text{O}$
 - $\text{C}_6\text{H}_5\text{N}_2\text{Cl}$, SnCl_2/HCl , $(\text{CH}_3\text{CO})_2\text{O}$
 - $\text{Br}_2/\text{H}_2\text{O}$, Zn/HCl , $(\text{CH}_3\text{CO})_2\text{O}$
- Which carbocation is formed most easily when cationic addition polymerisation of compound A is initiated by H^+ ?



- $\text{C}_6\text{H}_5-\underset{\text{CH}_3}{\text{CH}}\text{CH}_2\text{CH}_3^+$
- $\text{C}_6\text{H}_5-\underset{\text{CH}_3}{\text{CH}}\text{CH}_2\text{CH}_2^+$
- $\text{C}_6\text{H}_5-\text{C}^+(\text{CH}_3)-\text{CH}_2\text{CH}_3$
- $\text{C}_6\text{H}_5-\text{CH}^+\text{CH}(\text{CH}_3)\text{CH}_3$

- In which of the following polymers ethylene glycol is one of the monomer units?





10. Which of the following is not true?
 (a) Some disinfectants can be used as antiseptics.
 (b) Sulphadiazine is a synthetic antibacterial.
 (c) Aspirin is an analgesic as well as an antipyretic medicine.
 (d) Polystyrene is used to make non-stick cookwares.
11. Artificial sweetener which is stable under cold conditions only is
 (a) saccharin (b) sucralose
 (c) aspartame (d) alitame.
12. Beckmann rearrangement is involved in the synthesis of which of the following polymers?
 (a) PAN (b) Nylon 6,10
 (c) Nylon-6 (d) Melamine

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
 (b) If both assertion and reason are true but reason is not the correct explanation of assertion.
 (c) If assertion is true but reason is false.
 (d) If both assertion and reason are false.

13. **Assertion :** Chloramphenicol is a bacteriostatic antibiotic.
Reason : It kills the organism in the body.

14. **Assertion :** Vinylidene chloride forms isotactic, syndiotactic and atactic polymers.

Reason : Vinylidene chloride contains chiral carbon atoms.

15. **Assertion :** Olefinic monomers undergo addition polymerisation.

Reason : Polymerisation of vinyl chloride is initiated by peroxides/persulphates.

JEE MAIN / JEE ADVANCED

Only One Option Correct Type

16. Consider the following statements.
 (I) Antibiotics which kill the microorganisms are known as bactericidal drugs.
 (II) Antibiotics which inhibit the growth of microorganisms are known as bacteriostatic drugs.

(III) Penicillin is a broad spectrum antibiotic.

Correct statements are

- (a) (II) and (III) (b) (I), (II) and (III)
 (c) (I) and (II) (d) (I) and (III)

17. Consider the following statements :

- I. Cationic-polymerisation occurs in monomers with electron-donating substituents.
 II. Anionic-polymerisation occurs in monomers with electron-withdrawing substituents.
 III. Head-to-head chain-growth polymerisation occurs in polystyrene.

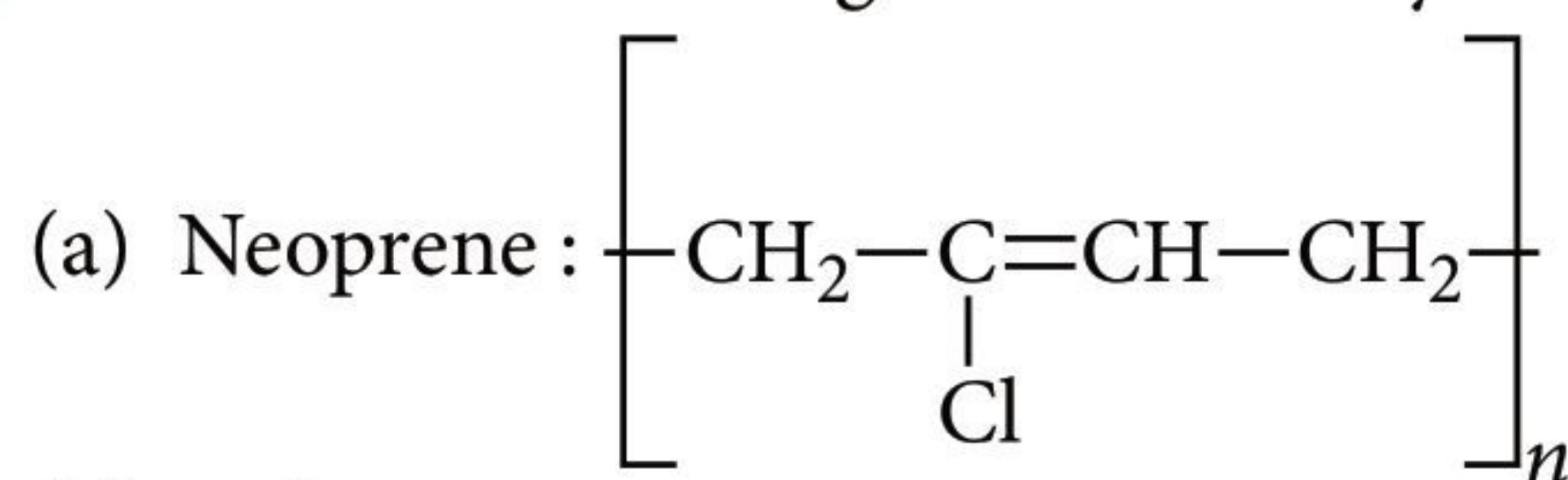
The correct statements are

- (a) I and II (b) I and III
 (c) II and III (d) I, II and III

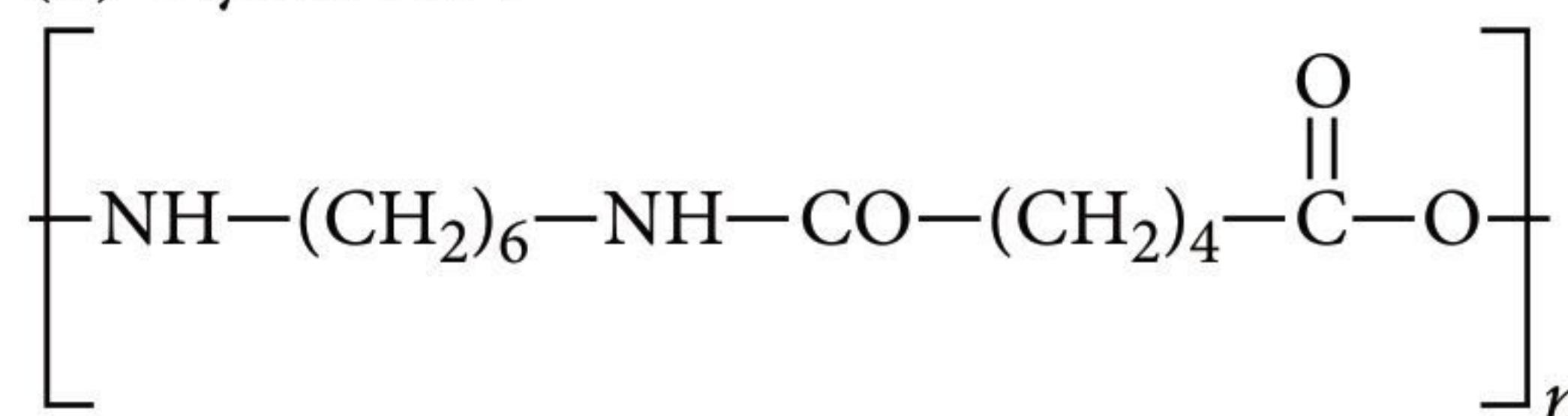
18. Antiseptics and disinfectants either kill or prevent growth of micro-organisms. Identify which of the following statements is not true?

- (a) Dilute solution of boric acid and hydrogen peroxide are strong antiseptics.
 (b) Disinfectants harm the tissues.
 (c) A 0.2% solution of phenol is an antiseptic while 1.0% solution is disinfectant.
 (d) Tincture of iodine is a powerful antiseptic.

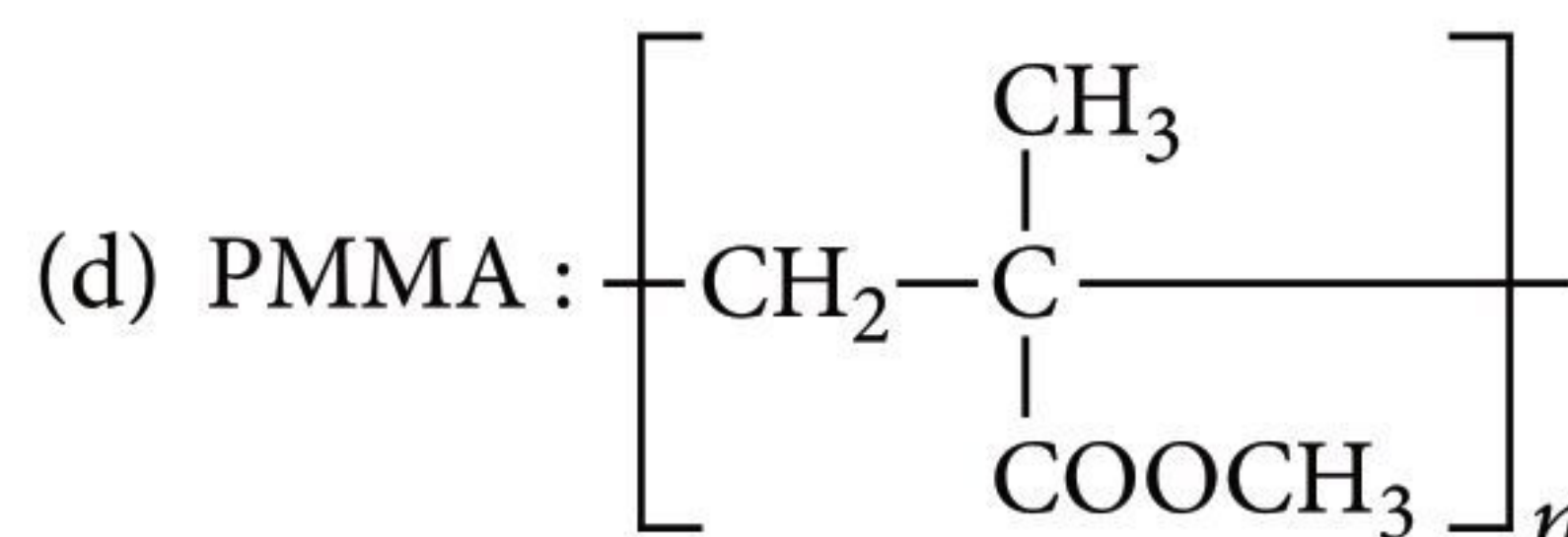
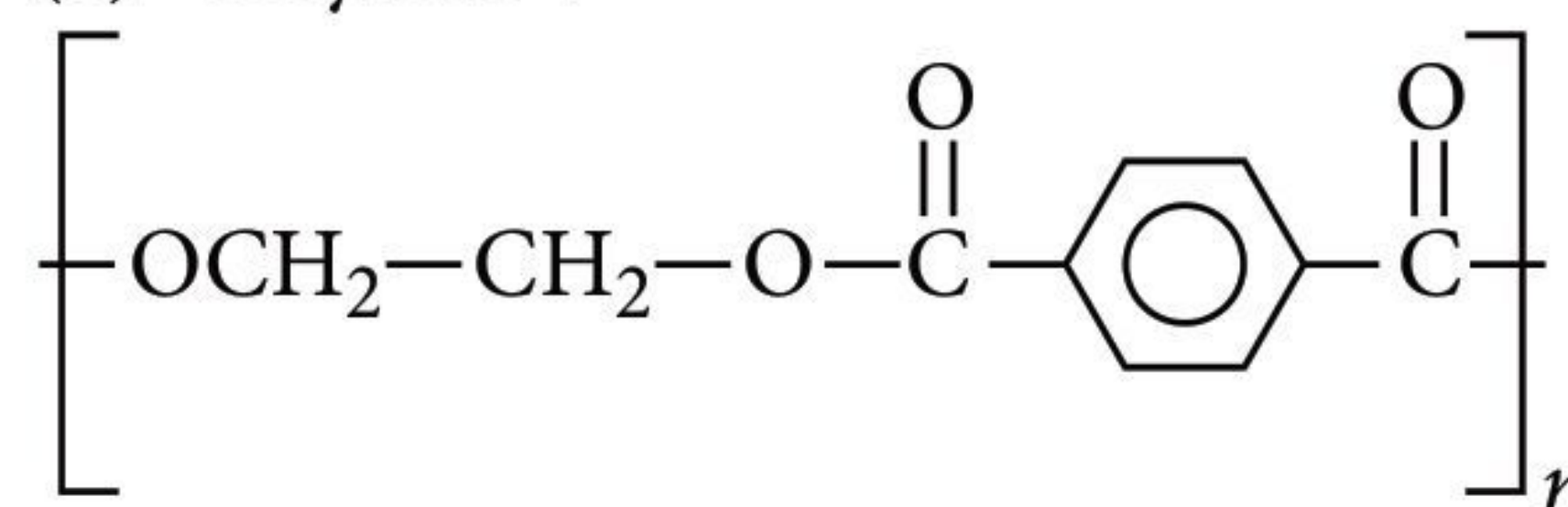
19. Which of the following is not correctly matched?



(b) Nylon-6,6 :



(c) Terylene :



More than One Options Correct Type

20. Which of the following statements are correct about barbiturates?
 (a) They are hypnotics or sleep inducing agents.
 (b) They are tranquilizers.

- (c) They are non-narcotic analgesics.
 (d) They reduce pain without disturbing the nervous system.

21. Among the following, chain transfer reagent(s) are
 (a) carbon tetrachloride
 (b) benzoyl peroxide
 (c) benzoquinone
 (d) carbon tetrabromide.

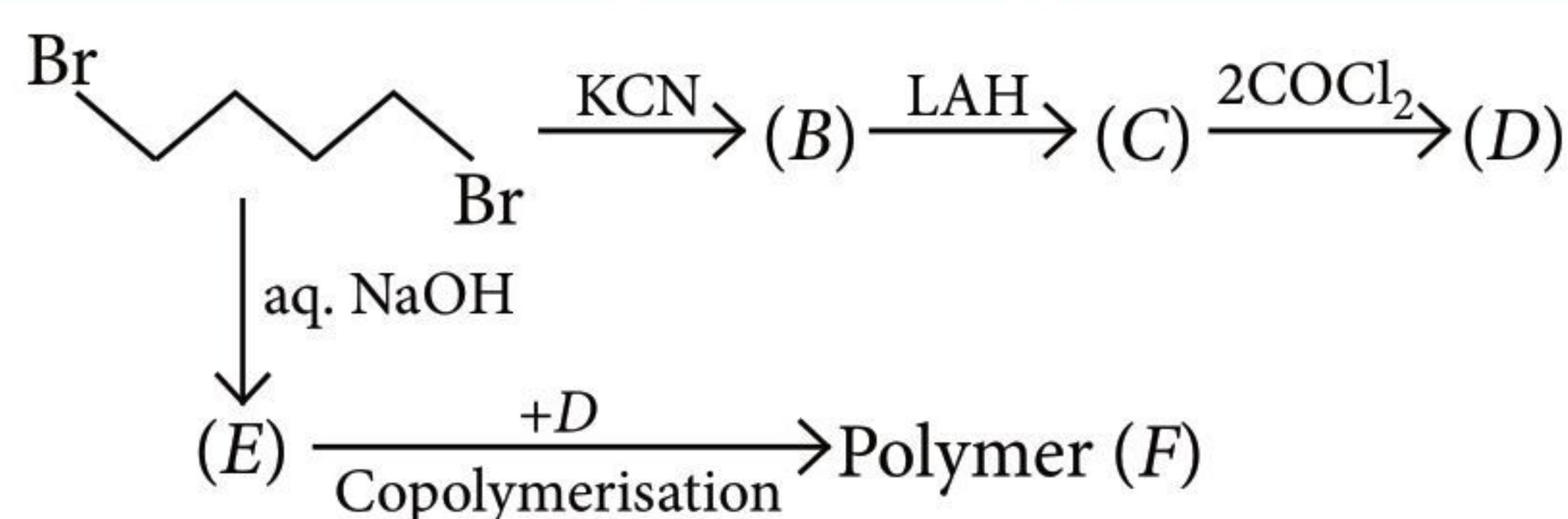
22. Which of the following statements are correct?
 (a) Cationic detergents have germicidal properties.
 (b) Bacteria can degrade the detergents containing highly branched chains.
 (c) Some synthetic detergents can give foam even in ice cold water.
 (d) Synthetic detergents are not soaps.

23. Which of the following behave as surfactants?
 (a) Soap (b) Detergents
 (c) Phospholipids (d) Triglycerides

Integer / Numerical Value Type

24. Percentage of sulphur used in the vulcanisation of rubber which is used in tyres is _____.
25. x percent solution of phenol acts as a disinfectant. x is _____.
26. The number of polymers that are biodegradable in nature in the given list is _____.
 Cellulose, PVC, polystyrene, glyptal, dextran, PHBV, nylon-2-nylon-6, nylon-6,6, PAN.

Comprehension Type


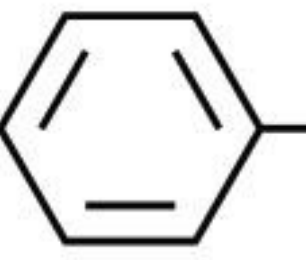



27. Compound (B) is
 (a) $\text{Br}(\text{CH}_2)_4\text{CH}_2\text{NH}_2$ (b) $\text{NC}(\text{CH}_2)_4\text{CN}$
 (c) $\text{NC}(\text{CH}_2)_6\text{Br}$ (d) $\text{NC}(\text{CH}_2)_6\text{CN}$

28. The polymer (F) is
 (a) Polyurethane (b) PMMA
 (c) PAN (d) Nylon-6, 6

Matrix Match Type

29. Match the copolymers given in List I with their monomers in List II and select the correct answer using the code given below the lists.

List I	List II
P. Saran	1.  -CH=CH ₂ , CH ₂ =CH-CH=CH ₂
Q. San	2.  -CH=CH ₂ , CH ₂ =CH-CH=CH ₂ , CH ₂ =CHCN
R. ABS	3. CH ₂ =CHCl, CH ₂ =CCl ₂
S. SBR	4.  -CH=CH ₂ , CH ₂ =CHCN

	P	Q	R	S
(a)	1	2	3	4
(b)	3	4	2	1
(c)	2	1	4	3
(d)	3	4	1	2

30. Match the List I with List II and select the correct answer using the code given below the lists :

List I	List II
(A) Salol	(P) Anaesthetic
(B) Methyl salicylate	(Q) Antiseptic
(C) Diethyl ether	(R) Disinfectant
(D) Formaline	(S) Pain balm
(a) A-Q; B-S; C-R; D-P, S	
(b) A-P; B-Q; C-R; D-P, S	
(c) A-P; B-R; C-Q, S; D-S	
(d) A-Q; B-S; C-P; D-Q, R	

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 No. of questions correct
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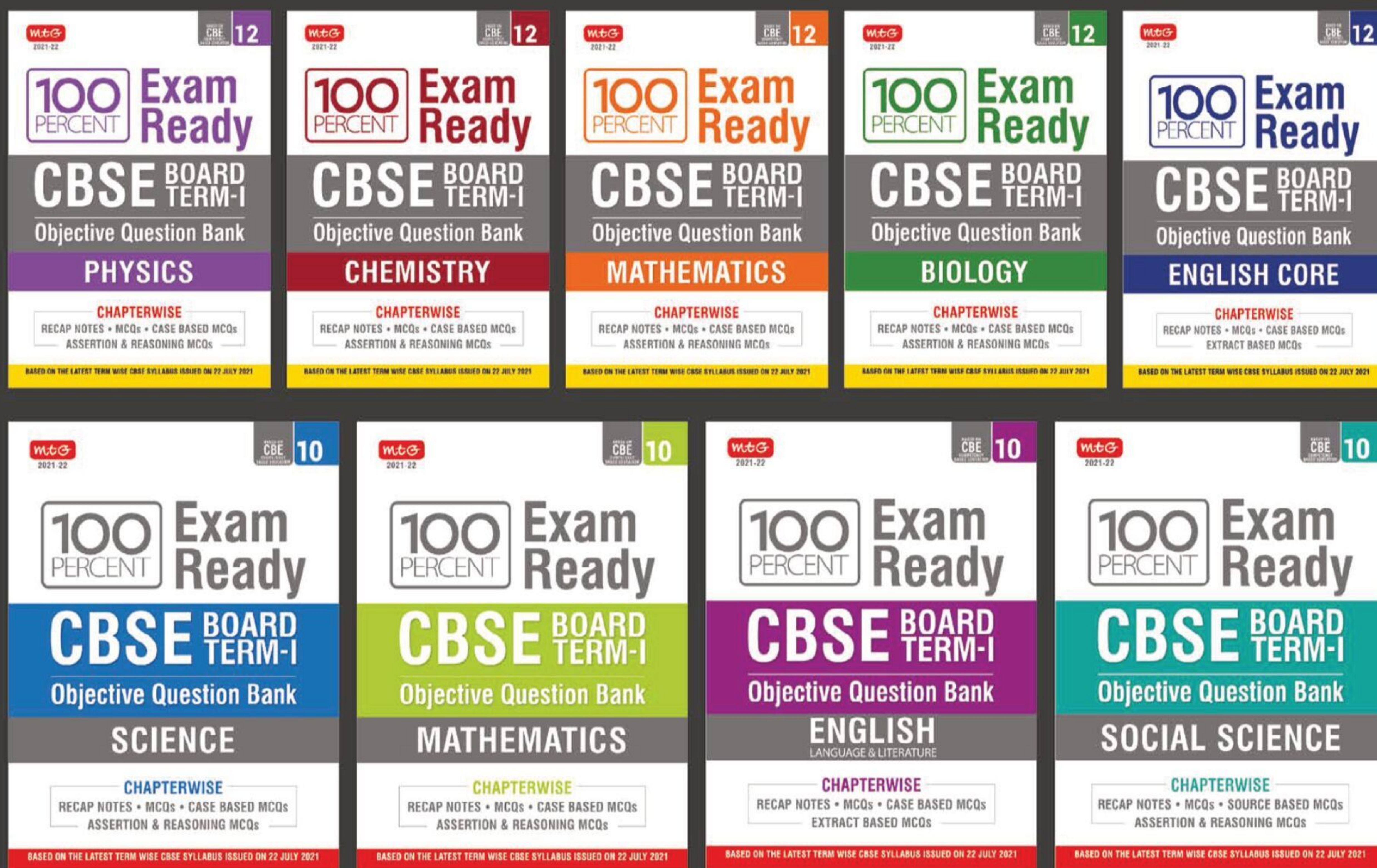
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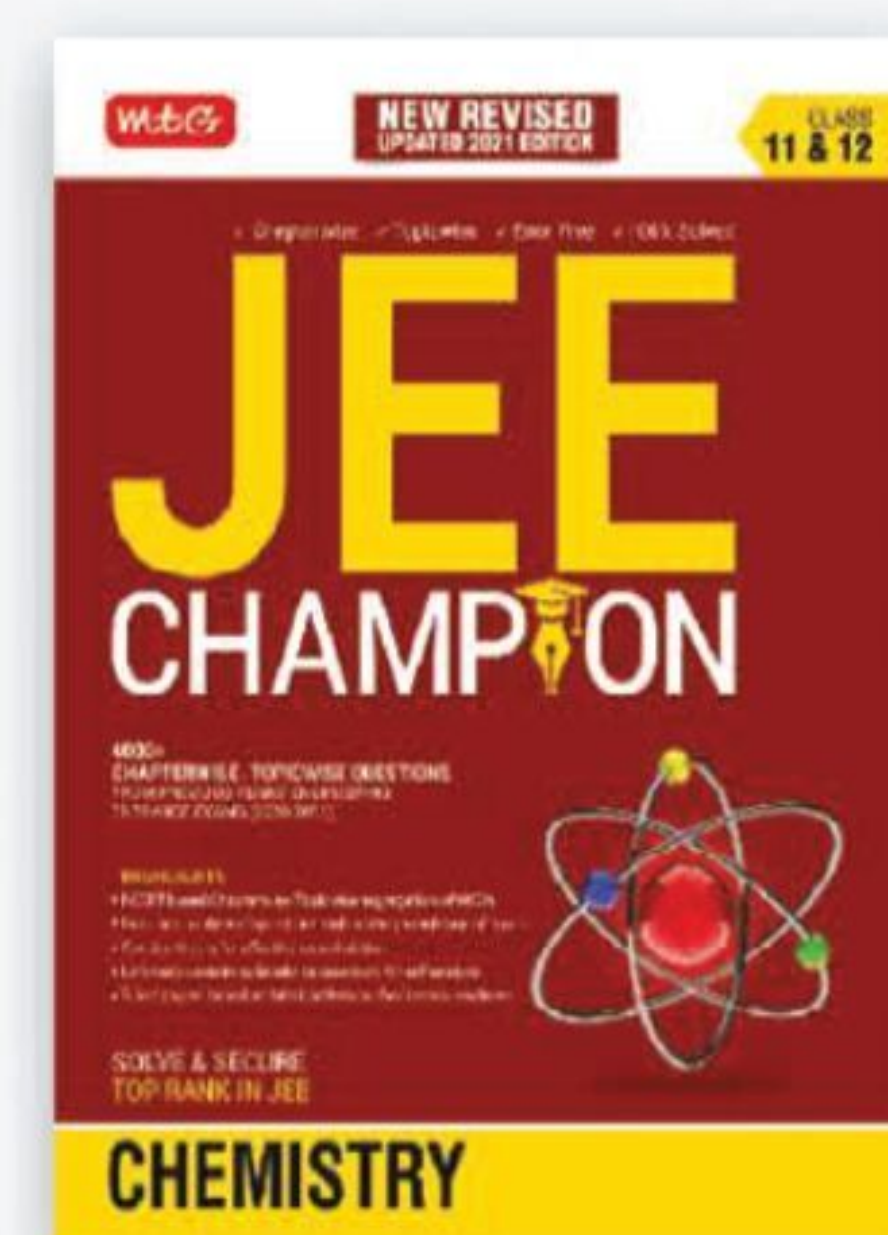
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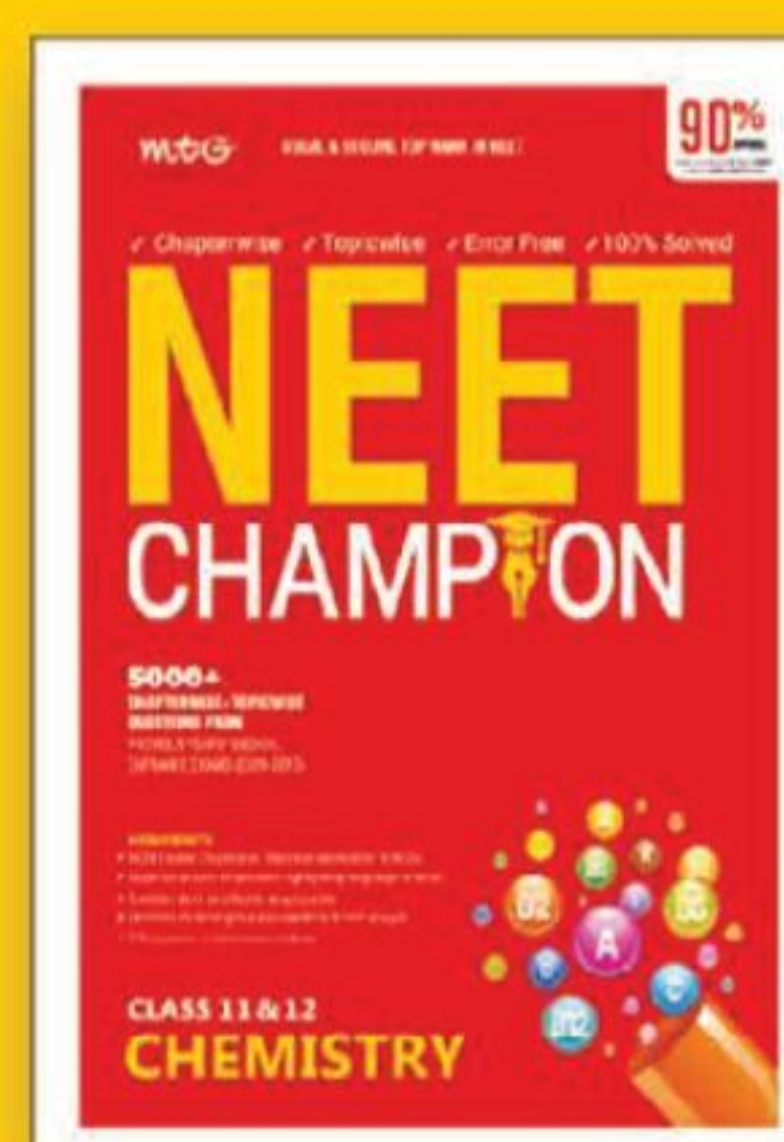


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